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THE DYNAMIC PROPERTIES OF THE FULL JOURNAL BEARING,  
CONSIDERING CAVITATION

BY

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CONSIDERING CAVITATION

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ABSTRACT

THE DYNAMIC PROPERTIES OF THE FULL JOURNAL BEARING,

CONSIDERING CAVITATION

by Richard A. Kaufer

Submitted to the Department of Naval Architecture and Marine Engineering and the Department of Mechanical Engineering on 20 May, 1966 in partial fulfillment of the requirements for the degree of Naval Engineer and the degree of Master of Science in Mechanical Engineering.

The unsteady motion of a circumferentially grooved journal bearing is analyzed and programmed on a digital computer, using the short bearing approximation of Reynolds' equation. The boundary conditions of continuity are used, and particular emphasis is placed on determining the effect of the size and shape of the cavitation zone on the unsteady characteristics of the bearing.

Tabulated data consisting of bearing loads, load angles, and spring and damping coefficients are presented for a wide range of bearing dimensions and operating conditions. A computer program is also written which can be used to obtain a wider range of values than are tabulated, and/or as a subroutine in an analysis of a journal bearing supported system.

The analysis shows that the dynamic properties of a journal bearing are greatly influenced by the shape and extent of the cavitation zone, thus indicating a need for experimental work with the primary object of ascertaining film behavior under unsteady conditions.

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## NOMENCLATURE

$B_{mm}$	damping coefficient, as in $B_{rr}$ ; lb-sec/in.
BNM	dimensionless damping coefficient, $\frac{B_{mm} c}{p_a LR}$
$c$	radial bearing clearance; in.
CB	bearing center
CJ	journal center
CJ'	perturbed journal center
$d$	perturbation of journal center; in.
$D$	journal diameter; in.
$e$	journal eccentricity; in.
$2F$	total bearing load; lb.
$2F_0$	total steady state bearing load; lb.
$\bar{F}$	dimensionless bearing load, $\frac{2F_0}{p_a LR}$
$F_1, F_2$	bearing forces in 1 and 2 directions respectively; lb.
$F_{10}, F_{20}$	steady state bearing forces in the 1 and 2 directions respectively; lb.
$F_r, F_s$	bearing forces in r and s directions respectively; lb.
$h$	radial bearing clearance at any point; $c(1 + n \cos \theta)$ ; in.
$h^*$	radial bearing clearance along the upstream boundary of the cavitated zone; $c(1 + n \cos \theta^*)$ ; in.
$I$	$\int h^* dz$
$K_{mm}$	spring coefficient, as in $K_{rr}$ ; lb/in.
KNM	dimensionless spring coefficient, $\frac{K_{mm} c}{p_a LR}$
$2L$	total bearing length, excluding circumferential groove; in.
$n$	eccentricity ratio, $\frac{e}{c}$



$p$	pressure at any point; psia.
$p_o$	feed pressure; psia.
$p'$	feed pressure, $(p_o - p_a)$ ; psig.
$p_a$	ambient pressure; psia.
PR	pressure ratio, $\frac{p_o}{p_a}$
$Q_m$	volumetric flow in the $m$ direction; in <sup>3</sup> /sec.
$R$	journal radius
$r,s$	radial and tangential reference axis
$u,v,w$	fluid velocities in the $x,y$ , and $z$ directions respectively
$v$	perturbation of journal center; in/sec.
$w$	film width at any point measured from the circumferential groove; in.
$x,y$	horizontal and vertical reference axis
$x,y,z$	film coordinate axis
$\cdot$	$\frac{d}{dt}$
$\delta$	width of a oil striation at the downstream boundary of the cavitated zone; in.
$\delta^*$	width of a oil striation at the upstream boundary of the cavitated zone; in.
$\emptyset$	angle between bearing load and line of centers; radians
$\omega$	rotational speed of journal; radians/sec.
$\omega$	relative tangential velocity between journal and bearing, $(\omega - 2\emptyset)$ ; radians/sec.
$\Lambda^*$	dimensionless squeeze, $\frac{\mu \omega}{p_a} \left(\frac{L}{c}\right)^2$
$\mu$	viscosity; lb-sec/in <sup>2</sup> .
$\theta$	angle between line of centers and any point on the journal; radians
$\tau$	shear stress; psia.



## INTRODUCTION

### Background

The knowledge of the dynamic properties of a journal bearing is necessary in the design stage both to ascertain the inherent stability of the bearing itself and to predict the overall response of a bearing supported system to external and internal excitations. Some of the many problems which can be encountered are self excited half speed whirl, excessive amplitude of vibration of the journal within the bearing near the critical speed of the system, and the inability of the system to recover from a dynamic load.

Since Reynolds derived the three dimensional, continuity, differential equation for determining the pressure distribution in an oil film between two moving surfaces, all journal bearing investigations have used Reynolds' equation, usually in one of two simplified forms because of its mathematical formidability. In the two dimensional or infinite bearing simplification, the pressure induced flow in the axial direction is neglected. In the short bearing simplification, the pressure induced flow in the circumferential direction is neglected by assuming that it is much less than the velocity induced flow caused by the relative motion between the journal and the bearing.

However, defining and applying the proper boundary conditions has proved to be the most difficult task in obtaining a good solution to Reynolds' equation, even in one of the reduced forms and under steady state conditions. Sommerfeld, in 1904, was the first to obtain an exact solution to Reynolds' two dimensional equation, but his solution allowed negative pressures in the diverging portion of the bearing. This led to the theory that under certain conditions of loading, vaporization could occur because a fluid is unable to support any appreciable tensile force. This theory has since been verified





by making observations of translucent bearings which clearly show film rupture[1],[2],[3],[4]. Theoretically, the cavitation pressure should be the vapor pressure of the fluid, but in actual practice the cavitation pressure has been found to be very nearly ambient pressure because of entrapped air and other gases.

In 1952, Ockvirk[5] developed a steady state solution of Reynolds' equation using the short bearing approximation and assuming that the entire unloaded half of the bearing was cavitated and at zero pressure. More recently, Fedor[6] and Donaldson[7] obtained solutions of Reynolds' three dimensional equation using series solutions and applying Sommerfeld's boundary conditions, but requiring that the feed pressure be sufficiently high so as to suppress cavitation. However, this is an unrealistic situation in most bearing applications, particularly those in which stability is a problem.

Two recent analyses of unsteady motion are of special interest in this investigation. Holmes[8] extended Ockvirk's solution to the particular case of a rigid shaft supported by symmetrical bearings. Richardson[9] also used the short bearing approximation, but defined the cavitation boundary more rigorously by assuming that there was a zero pressure gradient along the boundary and by assuming that the shape and extent of the cavity was a function of feed pressure and squeeze. Richardson obtains a solution to his analysis by digital methods. However, both Holmes and Richardson violate continuity since they do not consider the oil entering and subsequently leaving the cavitation zone.

In 1957, theories which took into account continuity of flow through the cavitation zone were independently developed by Floberg[10] and Rightmire[11]. Experimental work by Floberg and Ishii[4] has indicated a close agreement with the continuity theory under steady state conditions.



### Purpose

The purpose of this investigation is to analyze the unsteady motion of a circular, circumferentially grooved journal bearing, using the short bearing approximation and the boundary conditions of continuity. A circumferentially grooved journal bearing was chosen because its line source makes the feeding arrangement independent of the journal attitude within the bearing. The results of this analysis will be presented in two forms: a computer program which can be used as a subroutine in a systems analysis, and in the form of tabulated data of spring and damping coefficients for use in hand calculations.



## ANALYSIS OF UNSTEADY MOTION

### Assumptions

In arriving at a solution of Reynolds' equation which will adequately describe the unsteady motion and dynamic properties of a circumferentially grooved journal bearing, the following assumptions will be made:

1. The fluid is Newtonian and incompressible.
2. The viscosity is constant.
3. The flow is laminar.
4. The mass of the fluid is negligible.
5. Surface tension is negligible.
6. The fluid adheres to the journal and bearing surfaces.
7. There is no distortion of the journal or bearing surfaces due to hydrodynamic pressure; only light and moderately loaded bearings will be considered.
8. The fluid film is so thin that it has no curvature.
9. The fluid film is so thin that there is no pressure gradient across the film.
10. The vapor pressure of the fluid is equal to ambient pressure.
11. The pressure induced flow in the circumferential direction is negligible compared to the velocity induced flow in the circumferential direction
12. In the cavitated region, the fluid divides into an infinite number of streamers.

The last two assumptions will be discussed in greater detail in later sections; the remaining assumptions are self explanatory.

### Journal Bearing Oil Film Theory

Figure I illustrates the general case of the unsteady motion of a journal within a fixed rigid bearing. At any instant in time the journal has a rotational speed  $\omega$  about



Figure I  
Journal-bearing motion referred to a fixed point in space

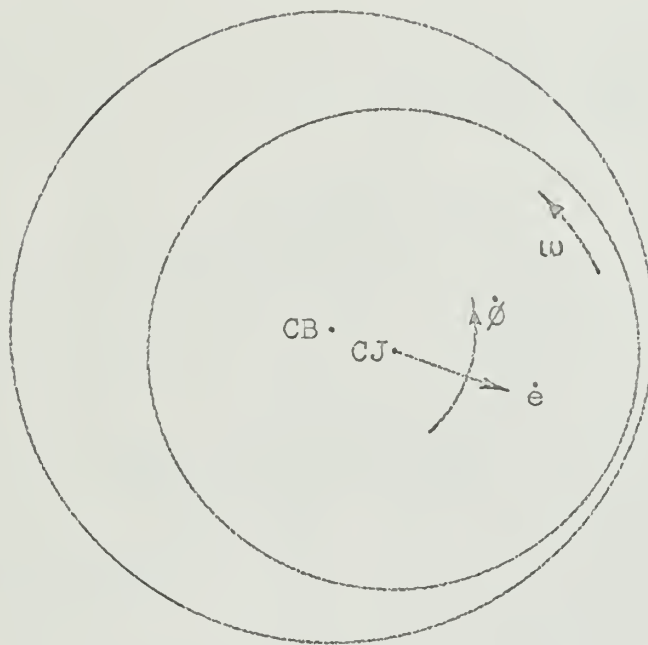


Figure II  
Journal-bearing motion referred to the line of centers

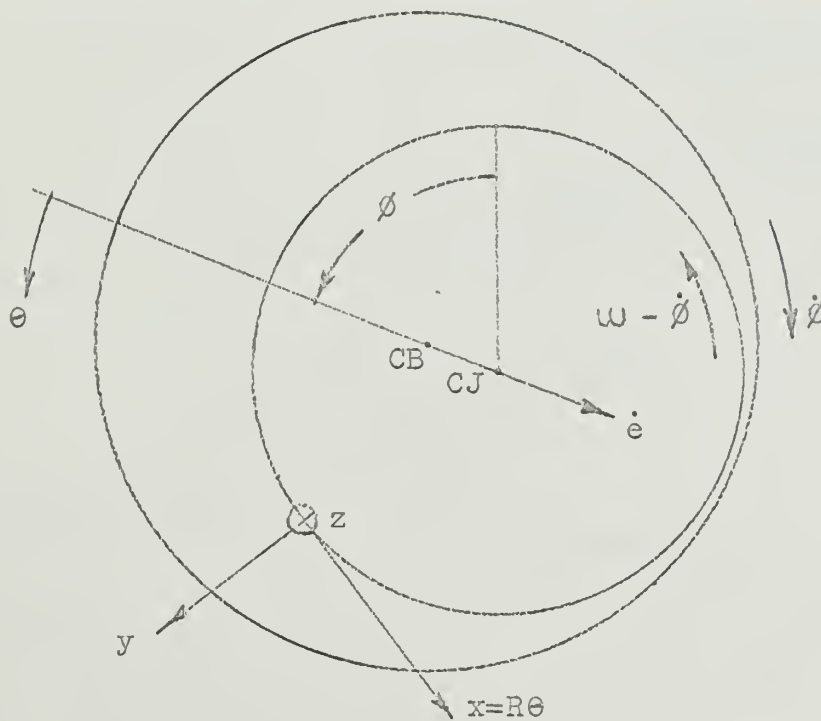






Figure III  
Oil film forces in the x direction

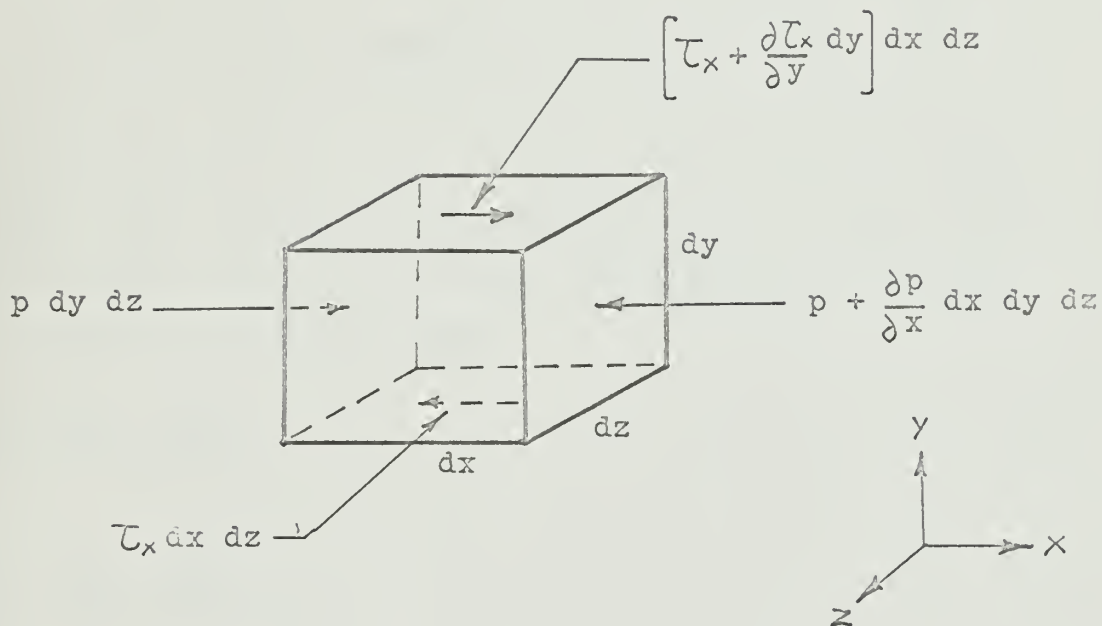
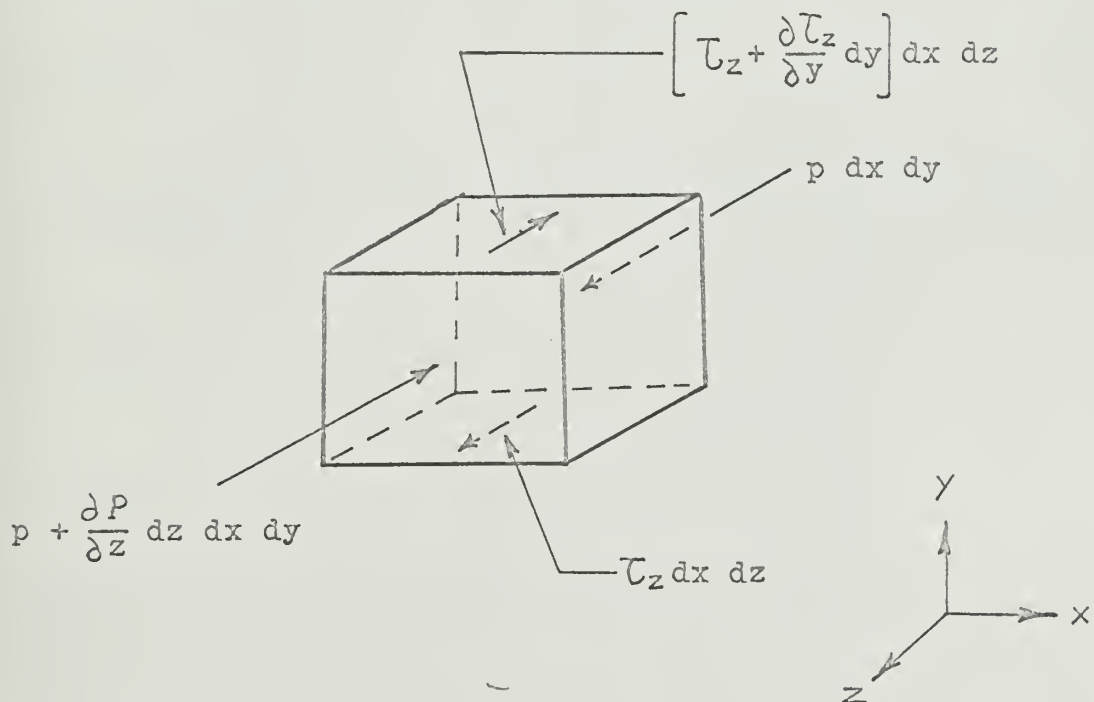


Figure IV  
Oil film forces in the z direction





its own center CJ, an orbital speed of  $\dot{\phi}$  about the bearing center CB and a radial velocity  $\dot{e}$ . However in analyzing this system, it is more convenient to fix the line of centers in space and use that line as a reference as shown in Figure II. Then the journal has a clockwise rotational speed of  $(\omega - \dot{\phi})$  and the bearing has counterclockwise rotational speed of  $\dot{\phi}$ .

The forces acting in the x and z directions on an elemental cube dx dy dz are shown in Figures III and IV, where u, v, and w are the fluid velocities in the x, y, and z directions respectively at any point. Equilibrium of forces in the x and y direction yields:

$$\frac{\partial p}{\partial x} = \frac{\partial \tau_x}{\partial y} + \frac{\partial \tau_x}{\partial z} \quad (1)$$

$$\frac{\partial p}{\partial z} = \frac{\partial \tau_z}{\partial y} + \frac{\partial \tau_z}{\partial x} \quad (2)$$

With the assumption that the film is so thin that has no pressure gradient across it;

$$\frac{\partial p}{\partial y} = 0$$

The sheer stresses are obtained from Newton's law for laminar viscous flow[12]:

$$\tau_x = \mu \frac{\partial u}{\partial y}$$

$$\tau_z = \mu \frac{\partial w}{\partial y}$$

Substituting these expressions into equations 1 and 2 gives:



$$\frac{\partial p}{\partial x} = \mu \frac{\partial^2 u}{\partial y^2} + \mu \frac{\partial^2 u}{\partial y \partial z} = \mu \frac{\partial}{\partial y} \left[ \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} \right] \quad (3)$$

$$\frac{\partial p}{\partial z} = \mu \frac{\partial^2 w}{\partial y^2} + \mu \frac{\partial^2 w}{\partial x \partial z} = \mu \frac{\partial}{\partial y} \left[ \frac{\partial w}{\partial y} + \frac{\partial w}{\partial x} \right] \quad (4)$$

Again considering the fact that the film is very thin in the y direction, so that the velocity gradients in the y direction are much greater than the velocity gradients in the x and z directions:

$$\frac{\partial w}{\partial x} \ll \frac{\partial w}{\partial y}$$

$$\frac{\partial u}{\partial z} \ll \frac{\partial u}{\partial y}$$

Then equations 3 and 4 become:

$$\frac{\partial p}{\partial x} = \mu \frac{\partial^2 u}{\partial y^2} \quad (5)$$

$$\frac{\partial p}{\partial z} = \mu \frac{\partial^2 w}{\partial y^2} \quad (6)$$

With the assumption of constant viscosity, equations 5 and 6 can be integrated twice:

$$u = \frac{1}{2\mu} \frac{\partial p}{\partial x} y^2 + C_1 y + C_2 \quad (7)$$

$$w = \frac{1}{2\mu} \frac{\partial p}{\partial z} y^2 + C_3 y + C_4 \quad (8)$$



where  $C_1$ ,  $C_2$ ,  $C_3$ , and  $C_4$  are constants of integration.

From Figure II, the boundary conditions are:

$$\text{at } y = 0: \quad u = (\omega - \dot{\phi})R, \quad w = 0$$

$$\text{at } y = h: \quad u = -\dot{\phi}R, \quad w = 0$$

where  $h$  is the film thickness at any  $x$ .

Applying these boundary conditions to equations 7 and 8:

$$u = \frac{1}{2\mu} \frac{\partial p}{\partial x} (y^2 - hy) - \frac{\omega R}{h} y + (\omega - \dot{\phi})R \quad (9)$$

$$w = \frac{1}{2\mu} \frac{\partial p}{\partial z} (y^2 - hy) \quad (10)$$

With the assumption that the pressure induced flow in the circumferential direction is much less than the velocity induced flow due to the relative motion between the journal and the bearing, equation 9 becomes:

$$u = -\frac{\omega R}{h} y + (\omega - \dot{\phi})R \quad (11)$$

The boundary velocities in the  $y$  direction are:

$$\text{at } y = 0, \quad v = \dot{y}$$

$$\text{at } y = h, \quad v = 0$$

By continuity:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

Substituting equations 10 and 11 into the continuity equation:





$$\frac{\partial}{\partial x} \left( \left[ -\frac{\omega R}{h} y + (\omega - \dot{\theta}) R \right] dy \right) + \frac{\partial}{\partial y} (y \, dy) + \frac{\partial}{\partial z} \left( \frac{1}{2\mathcal{M}} \left[ \frac{\partial p}{\partial z} (y^2 - hy) \right] dy \right) = 0$$

Integrating the above expression from  $y = 0$  to  $y = h$  and applying the boundary velocities in the  $y$  direction, the final result is the short bearing approximation of Reynolds' equation for unsteady motion:

$$\frac{\partial^2 p}{\partial z^2} = \frac{6\mathcal{M}}{h^3} \mathcal{A}_R \frac{\partial h}{\partial x} - \frac{12}{h^3} \dot{y} \quad (12)$$

where  $\mathcal{A} = (\omega - 2\dot{\theta})$

This equation is much easier to manipulate and solve than Reynolds' complete equation, and for moderately loaded bearings with length to diameter ratios of less than  $\frac{1}{2}$  the loss of accuracy introduced by the short bearing simplification can be expected to be of the same order of magnitude as some of the other assumptions which were necessary to make. A comparison between an exact solution obtained by Donaldson [7] under steady state conditions ( $\dot{\theta} = 0, \dot{e} = 0$ ) and the results of this investigation is presented in Appendix A. It is proposed that the same deviations could be expected in the case of unsteady motion between exact and approximate solutions.

Again assuming constant viscosity, equation 12 can be integrated twice with respect to  $z$  to obtain the pressure distribution on the bearing surface:

$$p = \frac{3\mathcal{M}R\mathcal{A}}{h^3} \frac{\partial h}{\partial x} - \frac{6\mathcal{M}}{h^3} \dot{y} z^2 + C_1 z + C_2 \quad (13)$$



where  $C_1$  and  $C_2$  are constants of integration to be determined by the film boundary conditions.

Expressions for the unit flows in the x and z directions will be required in the next section for determining the cavitation boundaries. These expressions can readily be obtained by integrating the velocities u and v across the film as follows:

$$Q_x = \int_0^h u \, dy$$

$$Q_z = \int_0^h v \, dy$$

Substituting in equations 10 and 11 the final result is:

$$Q_x = -\frac{h^3}{12\mu} \frac{\partial p}{\partial x} \quad (14)$$

$$Q_z = (\omega - 2\dot{\phi}) \frac{Rh}{2} - \frac{h^3}{12\mu} \frac{\partial p}{\partial z} \quad (15)$$

### Film Boundary Conditions

The unwrapped oil film for one half of a circumferentially grooved journal bearing is shown in Figure V. The approximate shape of the cavitation zone as observed experimentally [1], [2], [3], [4], is defined by the boundary 1 - 2 - 3; for steady motion, point 1 occurs immediately downstream from the point of minimum film thickness ( $x = \pi R$ ) where the rate of film expansion is the greatest, but in the case of unsteady motion it must be assumed that cavitation could commence at any x. Since the vapor pressure of the fluid is assumed to be ambient, then the entire cavity must be at ambient pressure, with the result that one of the



boundary conditions is:

$$\text{at } z = w, p = p_a$$

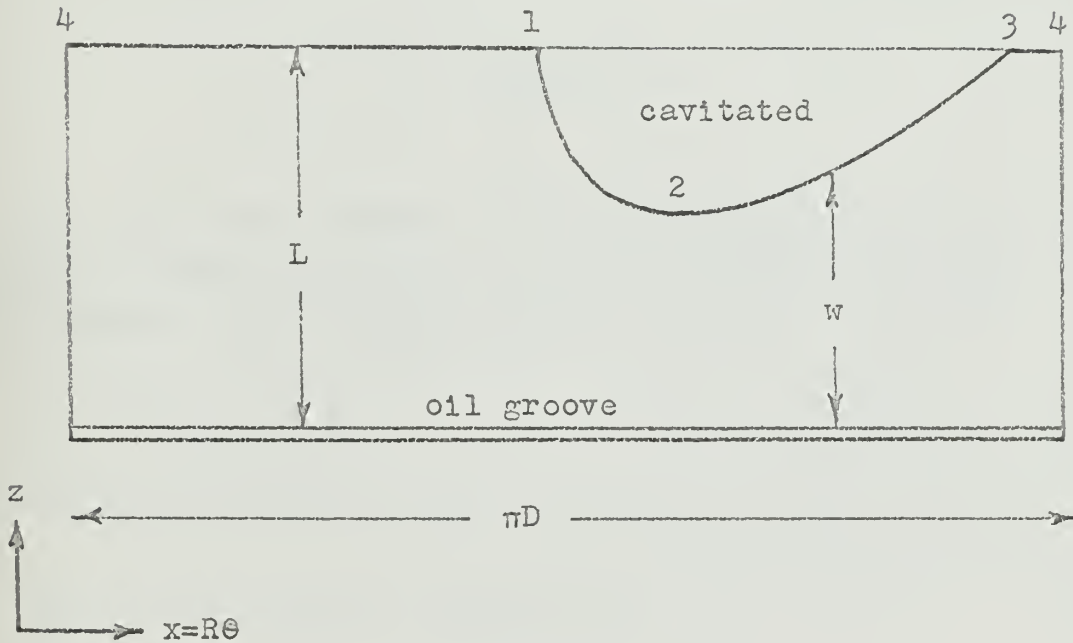
where  $w$  is the film width at any  $x$  and is equal to  $L$  where cavitation is not present.

Applying this boundary condition to equation 13, the result is:

$$p - p_a = \left[ \frac{3 R \mu \Lambda \partial h}{h^3} \frac{\partial}{\partial x} - \frac{6 \mu \cdot}{h^3} y \right] (z^2 - w^2) + C_1 (z - w) \quad (16)$$

Figure V

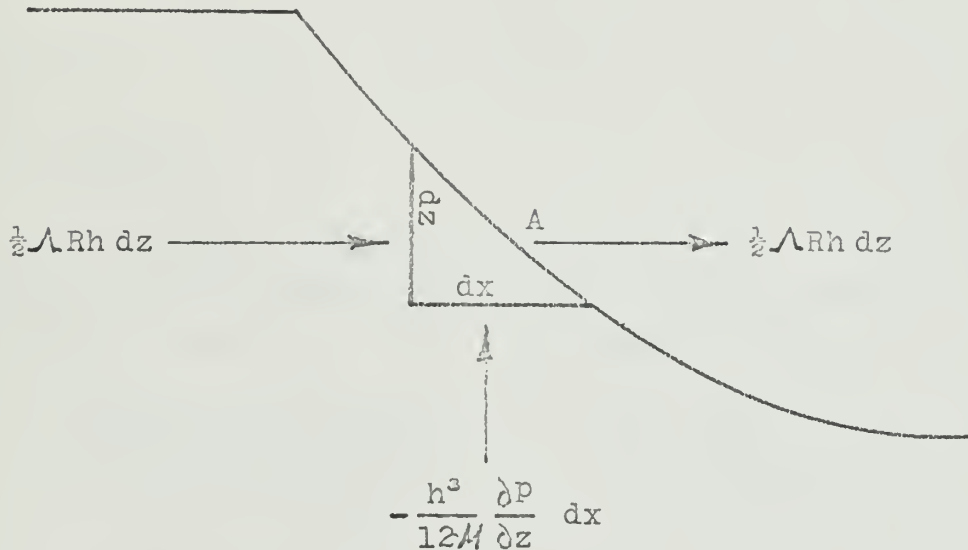
The unwrapped oil film



With the assumption that the fluid adheres to the surfaces of the journal and bearing, the fluid must split into one or more striations upon reaching the boundary 1 - 2 in order to satisfy continuity and to prevent subambient pressures from occurring. This is shown in Figure VI for the particular case where  $h_3 > h_1$ .



Figure VI  
Continuity of flow across the cavitation boundary



The upstream boundary 1 - 2 is determined by considering the flow through an elemental volume  $h \, dx \, dz$  at A. Then the flow entering the boundary at A is :

$$Q_{IN} = Q_x dx + Q_z dz$$

From equations 14 and 15 this becomes:

$$Q_{IN} = \frac{1}{2}(\omega - 2\dot{\phi})Rh \, dx - \frac{h^3}{12M} \frac{\partial p}{\partial z} \, dz$$

Since there are no pressure gradients in the cavitated zone, the only flow is velocity induced flow caused by the relative motion between journal and bearing. Thus the flow leaving the boundary at A must be:

$$Q_{OUT} = \frac{1}{2}(\omega - 2\dot{\phi})Rh \, dx$$

Therefore, by continuity of flow across the boundary:





$$\left. \frac{p}{z} \right|_A = 0$$

or:

$$\left. \frac{p}{z} \right|_w = 0$$

along boundary 1 - 2.

Applying this boundary condition to equation 16 to evaluate the constant C, the pressure distribution in the region bounded by  $z = 0$  and 3 - 4 - 1 - 2 is found to be:

$$p - p_a = \frac{3\mu}{h^3} (RA \frac{\partial h}{\partial x} - 2\dot{y})(z^2 - zw) + p'(1 - \frac{z}{w}) \quad (17)$$

where  $p' = p_o - p_a$

The first term on the right side of equation 17 is the hydrodynamic pressure distribution and the second term is the hydrostatic pressure distribution. The slopes of these two terms at  $z = w$ , are, respectively:

$$\left( \frac{\partial p}{\partial z} \right)_{hd} = \frac{3w\mu}{h^3} (RA \frac{\partial h}{\partial x} - 2\dot{y}) \quad (18)$$

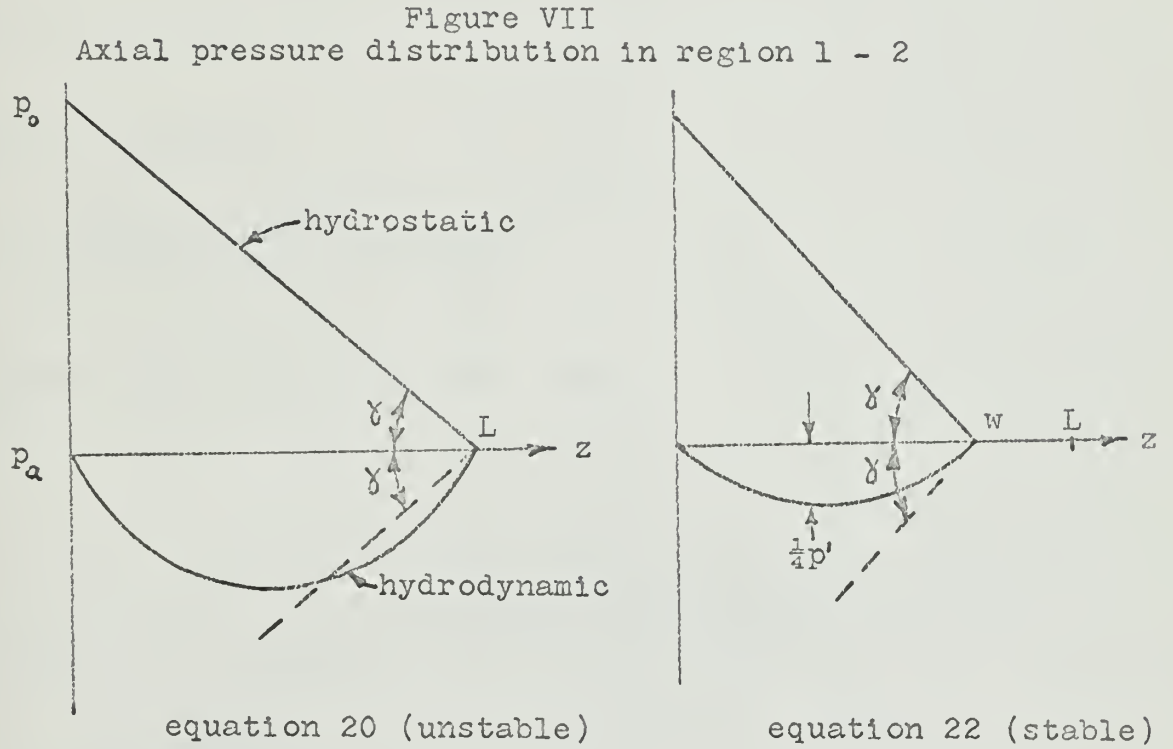
$$\left( \frac{\partial p}{\partial z} \right)_{hs} = - \frac{p'}{w} \quad (19)$$

The existence of cavitation at any  $x$  upstream from point 2 and downstream from point 3 can be ascertained by letting  $w = L$  in the above expressions. Then the condition for cavitation to occur is:

$$\frac{3L\mu}{h^3} (RA \frac{\partial h}{\partial x} - 2\dot{y}) > \left( \frac{p'}{L} \right) \quad (20)$$



i.e. the positive slope of the hydrodynamic pressure is greater than the negative slope of the hydrostatic pressure. This is illustrated in the left diagram of Figure VII.



If the condition for cavitation is satisfied (equation 20) then  $w$  adjusts so that:

$$\left( \frac{\partial p}{\partial z} \right)_{hd} + \left( \frac{\partial p}{\partial z} \right)_{hs} = 0$$

Substituting equations 18 and 19 into the above expression, the film width along boundary 1 - 2 is :

$$w^2 = \frac{p' h^3}{3\mu (R\mathcal{A} \frac{\partial h}{\partial x} - 2\dot{\gamma})} \quad (21)$$



Making the substitutions:

$$\frac{\partial h}{\partial x} = - \frac{cn}{R} \sin \theta$$

$$\dot{y} = - \dot{e} \cos \theta$$

Equation 21 becomes:

$$w = \sqrt{\frac{-p'h^3}{3\mathcal{M}(cn\Lambda \sin \theta - 2\dot{e} \cos \theta)}} \quad (22)$$

If equation 20 is not satisfied, then:

$$w = L$$

It can be seen that equation 22 is invalid for the downstream boundary 2 - 3 by considering the steady state case. Then equation 22 becomes:

$$w = \sqrt{\frac{-p'h^3}{3\mathcal{M} cn \omega \sin \theta}}$$

Under these conditions, the expression under the square root becomes negative at angles greater than  $\theta = 2\pi$ , implying that the cavitation zone cannot extend past  $\theta = 2\pi$ . Physically this would not necessarily be true for high journal speeds and low feed pressures.

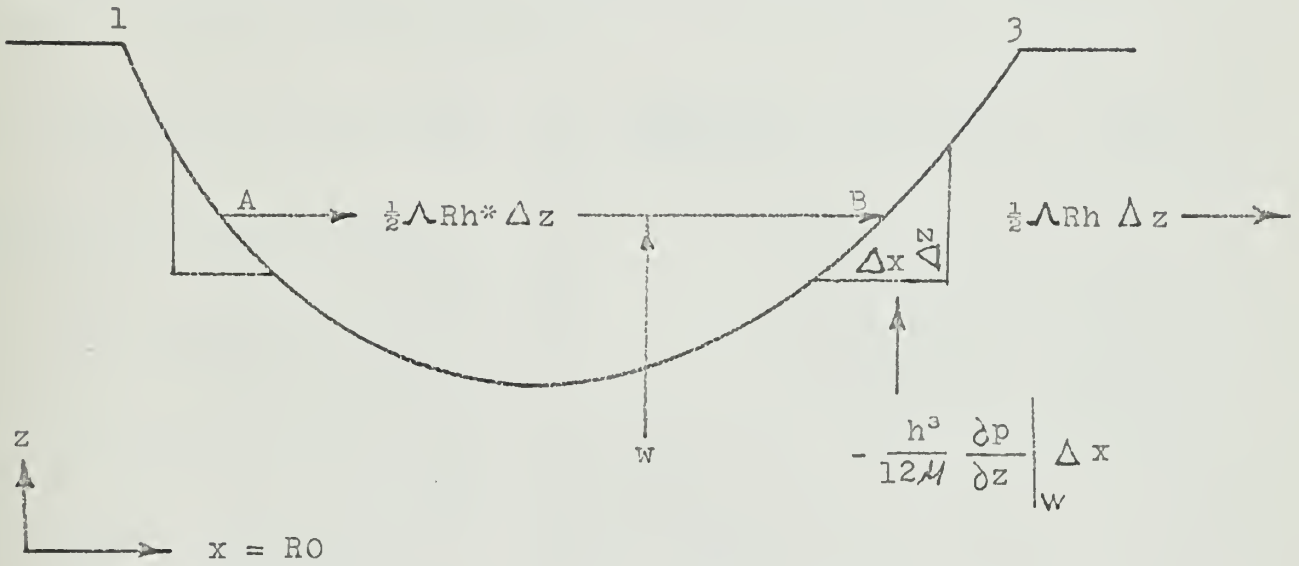
The downstream boundary is determined by considering continuity of flow through the cavity as illustrated in Figure VIII. Let the width of one striation at the upstream boundary be  $\Delta z$ . Then the amount of fluid in the striation as was previously determined is:

$$\frac{1}{2} \Lambda R h^* \Delta z$$



where  $h^*$  is the film thickness at  $z = w$  on the upstream boundary.

Figure VIII  
Continuity of flow across the downstream boundary



With the assumption that the fluid adheres to the journal and bearing surfaces, then by continuity the same amount of fluid must leave the cavity at  $z = w$  at point B on the downstream boundary. Since we have assumed that there are no pressure gradients in the cavity, there can be no motion of the striation in the  $z$  direction.

Summing up the total flow in the unit volume  $h \Delta x \Delta z$  at B, the result is :

$$\frac{1}{2} \Lambda R h^* \Delta z - \frac{h^3}{12 \mu} \left. \frac{\partial p}{\partial z} \right|_w \Delta x = \frac{1}{2} \Lambda R h \Delta z \quad (24)$$

From equation 17:

$$\left. \frac{\partial p}{\partial z} \right|_w = \frac{3 \mu}{h^3} (R \Lambda \frac{\partial h}{\partial x} - 2 \dot{y}) w - \frac{p'}{w} \quad (25)$$





Substituting equation 25 into 24:

$$\frac{1}{2} \Lambda R h^* \Delta z - \frac{h^3}{12 \mu} \left[ \frac{3}{h^3} (R \Lambda \frac{\partial h}{\partial x} - 2 \dot{y}) w - \frac{p'}{w} \Delta x \right] = \frac{1}{2} \Lambda R h \Delta z$$

Assuming an infinite number of striations, and then taking the limit as  $\Delta x \rightarrow dx$  and  $\Delta z \rightarrow dz$ :

$$\frac{1}{2} \Lambda R h^* dz - \left[ \frac{w}{4} (R \Lambda \frac{\partial h}{\partial x} - 2 \dot{y}) - \frac{h^3 p'}{12 \mu w} \right] dx = \frac{1}{2} \Lambda R h dz \quad (26)$$

Making the substitutions:

$$dx = R d\theta$$

$$dz \Big|_w = dw$$

$$\frac{\partial h}{\partial x} = - \frac{cn}{R} \sin \theta$$

$$\dot{y} = - \dot{e} \cos \theta$$

Equation 26 becomes:

$$\begin{aligned} \frac{1}{2} \Lambda R h^* dw - \left[ \frac{1}{4} w (-cn \Lambda \sin \theta + 2 \dot{e} \cos \theta) - \frac{h^3 p'}{12 w} \right] R d\theta \\ = \frac{1}{2} \Lambda R h dw \end{aligned}$$

or:

$$\frac{dw}{d\theta} = \frac{\frac{1}{2} w (cn \Lambda \sin \theta - 2 \dot{e} \cos \theta) + \frac{h^3 p'}{6 \mu w}}{\Lambda (h - h^*)} \quad (27)$$

The film width,  $w$ , in equation 27 is in terms of two variables,  $dw/d\theta$  and  $h^*$ , and so must be solved by an iteration method.



### Oil Film Forces

The oil film forces which will be considered are:

1. Hydrodynamic, hydrostatic and shear in the complete film region bounded by  $z = 0$  and 4 - 1 - 2 - 3 - 4 in Figure V.
2. Shear in the cavitation zone.

The differential hydrodynamic and hydrostatic force on a strip of the journal  $w, R d\theta$  is:

$$dF_p = \int_{z=0}^w p dz R d\theta$$

Substituting in  $p$  from equation 17:

$$dF_p = \int_{z=0}^w \left[ \frac{3\mu}{h^3} \left( R \Lambda \frac{h}{x} - 2\dot{y} \right) (z^2 - zw) + p'(1 - \frac{z}{w}) \right] dz R d\theta$$

which when integrated becomes:

$$dF_p = \left[ -\frac{w^3 R}{2h^3} \left( R \Lambda \frac{\partial h}{\partial x} - 2\dot{y} \right) + \frac{1}{2} p' w \right] R d\theta$$

Resolving this differential force in the 1 and 2 directions as shown in Figure IX:

$$dF_{p1} = dF_p \cos \theta$$

$$dF_{p2} = dF_p \sin \theta$$

The tangential shear stress in the complete film region due to the relative sliding velocity is (see Figure II):

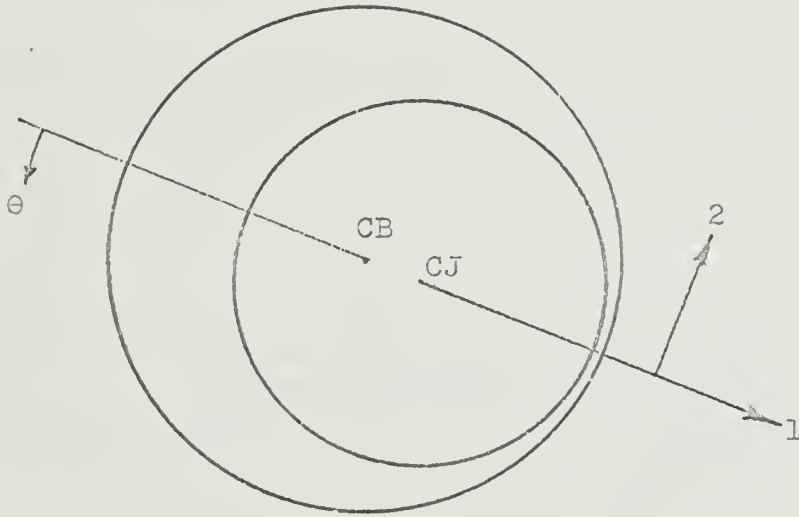
$$\tau = \frac{\mu}{h} (\omega R - \dot{\theta} e \cos \theta + \dot{e} \sin \theta)$$

However,  $\dot{\theta} e \ll \omega R$  and  $\dot{e} \ll \omega R$ , so that:

$$\tau \approx \frac{\mu \omega R}{h}$$



Figure IX  
Coordinate system for oil film forces



Then the differential force due to shear on a strip  $w$ ,  $Rd\theta$  is:

$$dF_s = \tau w R d\theta$$

Substituting in the value for  $\tau$ :

$$dF_s = \frac{\mu \omega R^2 w}{h} d\theta$$

Resolving the shear force in the 1 and 2 directions:

$$dF_{s1} = - dF_s \sin \theta d\theta$$

$$dF_{s2} = dF_s \cos \theta d\theta$$

In the cavitated zone, there is no hydrostatic pressure, since  $p = p_a$ . Also, since there are no pressure gradients, there is no pressure flow and thus no hydrodynamic pressure exists.



The shear forces in the cavitated zone are obtained by assuming an infinite number of striations as in the preceding section. Refer to Figure X where one striation is shown.

Figure X  
Continuity of a single oil striation



By continuity:

$$\frac{1}{2} \Lambda R h^* \delta^* = \frac{1}{2} \Lambda R h \delta$$

where  $\delta^*$  and  $\delta$  are the striation widths at the upstream and downstream boundaries respectively.

Then:

$$h^* \delta^* = h \delta$$

or:

$$\delta = \frac{h^* \delta^*}{h}$$

The differential shear force due to one striation at any  $\theta$  is:

$$df_s = \tau \delta R d\theta$$





Substituting in the expression for  $\delta$  from above:

$$df_s = \frac{MWR}{h} \frac{h^* \delta^*}{h} R d\theta$$

In the limit, as  $\delta^* \rightarrow dz$ :

$$df_s = \frac{MWR^2}{h^2} h^* dz d\theta$$

Then the differential force due to shear across the complete width of the cavitated zone at any  $\theta$  is:

$$dF_{sc} = \int_{z=w}^L \frac{MWR^2}{h^2} h^* dz d\theta$$

where the integral must be evaluated numerically.

Resolving the cavitated zone shear force in the 1 and 2 directions:

$$dF_{sc1} = -dF_{sc} \sin \theta d\theta$$

$$dF_{sc2} = dF_{sc} \cos \theta d\theta$$

Summing up the forces in the 1 and 2 directions and making the substitutions:

$$\frac{\partial h}{\partial x} = - \frac{cn}{R} \sin \theta$$

$$\dot{y} = - \dot{e} \cos \theta$$

Then the differential forces in the 1 and 2 directions are:

$$dF_1 = \left[ \frac{w^3 R}{2h^3} (\mathcal{A} cn \sin \theta - 2\dot{e} \cos \theta) \cos \theta + \frac{wR\dot{p}'}{2} \cos \theta - \frac{MWR^2 w}{h} \sin \theta - \frac{MWR^2 I}{h^2} \sin \theta \right] d\theta \quad (28)$$



$$dF_2 = \left[ \frac{w^3 R}{2h^3} (\Lambda \cos \theta - 2\dot{e} \sin \theta) \sin \theta + \frac{WRP'}{2} \sin \theta + \frac{MWR^2 w}{h} \cos \theta + \frac{M(WR^2 I)}{h^3} \cos \theta \right] d\theta \quad (29)$$

$$\text{where } I = \int_w^L h^* dz$$

Then:

$$F_1 = \int_0^{2\pi} dF_1$$

$$F_2 = \int_0^{2\pi} dF_2$$

which must be evaluated numerically.

The attitude angle is :

$$\phi = \tan^{-1} \left( \frac{F_2}{F_1} \right) \quad (30)$$

### Spring and Damping Coefficients

Refer to Figure XI. At a given instant of time the journal center is at CJ and is being acted upon by the forces  $F_1$  and  $F_2$  which were evaluated in the previous section. Now the journal is given a perturbed displacement,  $d$ , and a perturbed velocity,  $v$ , to the position CJ'; then the forces acting upon the journal are of the form:

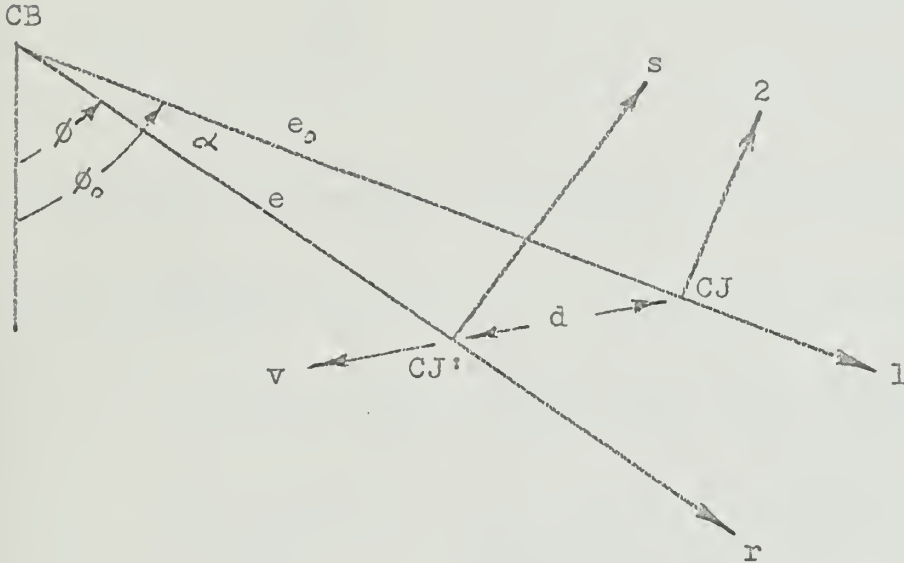
$$F_r = F_{10} + K_r(r, s) d + B_r(r, s) v$$

$$F_s = F_{20} + K_s(r, s) d + B_s(r, s) v$$

where  $F_{10}$  and  $F_{20}$  are the steady state forces at CJ; and  $K$  and  $B$  are spring and damping coefficients.



Figure XI  
Perturbation of journal center



In evaluating the previous equations it is first necessary to transfer the forces  $F_1$  and  $F_2$  to the  $r$  and  $s$  axis. However, it is more convenient to continue using differential forces; thus:

$$dF_r = dF_1 \cos \alpha - dF_2 \sin \alpha$$

$$dF_s = dF_1 \sin \alpha + dF_2 \cos \alpha$$

Since a small perturbation is being considered:

$$CJ \quad CJ' \ll CB \quad CJ'$$

Then:

$$\sin \alpha \approx \alpha = \frac{s}{e} = \frac{s}{cn}$$

$$\cos \alpha \approx 1$$



With these approximations, the differential radial and tangential forces become:

$$dF_r = dF_1 - dF_2 \frac{s}{cn} \quad (31)$$

$$dF_s = dF_1 \frac{s}{cn} + dF_2 \quad (32)$$

Substituting the equations 28 and 29 into equations 31 and 32:

$$\begin{aligned} dF_r = & \left\{ \frac{Mw^3R}{2h^3} \cos \theta \left[ -2\dot{e} \cos \theta + \Lambda nc \sin \theta \right] + \frac{1}{2} p'wR \cos \theta \right. \\ & - \frac{MWR^2w}{h} \sin \theta - \frac{MWR^2I}{h^2} \sin \theta - \frac{s}{cn} \left( \frac{Mw^3R}{2h^3} \sin \theta \right. \\ & \left. \left[ -2\dot{e} \cos \theta + \Lambda nc \sin \theta \right] + \frac{1}{2} p'wR \sin \theta \right. \\ & \left. \left. + \frac{MWR^2w}{h} \cos \theta + \frac{MWR^2I}{h^2} \cos \theta \right) \right\} d\theta \\ dF_s = & \left\{ \frac{s}{cn} \left( \frac{Mw^3R}{2h^3} \cos \theta \left[ -2\dot{e} \cos \theta + \Lambda nc \sin \theta \right] + \frac{1}{2} p'wR \cos \theta \right. \right. \\ & \left. - \frac{MWR^2w}{h} \sin \theta - \frac{MWR^2I}{h^2} \sin \theta \right) + \frac{Mw^3R}{2h^3} \sin \theta \\ & \left[ -2\dot{e} \cos \theta + \Lambda nc \sin \theta \right] + \frac{1}{2} p'wR \sin \theta \\ & \left. + \frac{MWR^2w}{h} \cos \theta + \frac{MWR^2I}{h^2} \cos \theta \right\} d\theta \end{aligned}$$

Let:

$$\dot{e} = \dot{r}$$

$$h = c(1 + n \cos \theta)$$

$$\dot{\theta} = \frac{\dot{s}}{cn}$$

Substituting the above into the equations for  $dF_r$  and  $dF_s$





and rearranging:

$$\begin{aligned}
 dF_r = & \left\{ \frac{\mathcal{M} w^3 R}{2c^3} \cos \theta \left[ -\frac{2r \cos \theta}{(1+n \cos \theta)^3} + \frac{\omega n c \sin \theta}{(1+n \cos \theta)^3} \right. \right. \\
 & - \left. \frac{2\dot{s} \sin \theta}{(1+n \cos \theta)^3} \right] + \frac{1}{2} p' w R \cos \theta - \frac{\mathcal{M} \omega R^2 w \sin \theta}{(1+n \cos \theta)c} \\
 & - \frac{\mathcal{M} \omega R^2 I \sin \theta}{c^2 (1+n \cos \theta)^2} - \frac{\mathcal{M} w^3 R \sin \theta}{2c^3} \left[ -\frac{2\dot{r} s}{c n (1+n \cos \theta)^3} \right. \\
 & + \left. \frac{\omega s \sin \theta}{(1+n \cos \theta)^3} - \frac{2\dot{s} s \sin \theta}{c n (1+n \cos \theta)^3} \right] - \frac{p' w R s \sin \theta}{2c n} \\
 & \left. - \frac{\mathcal{M} \omega R^2 w s \cos \theta}{c^2 n (1+n \cos \theta)} - \frac{\mathcal{M} \omega R^2 I s \cos \theta}{c^3 n (1+n \cos \theta)^2} \right\} d\theta \quad (33)
 \end{aligned}$$

$$\begin{aligned}
 dF_s = & \left\{ \frac{\mathcal{M} w^3 R \cos \theta}{2c^3} \left[ -\frac{2r s \cos \theta}{(1+n \cos \theta)^3 c n} + \frac{\omega s \sin \theta}{(1+n \cos \theta)^3} \right. \right. \\
 & - \left. \frac{2\dot{s} s \sin \theta}{c n (1+n \cos \theta)^3} \right] + \frac{p' s w R \cos \theta}{2c n} - \frac{\mathcal{M} \omega R^2 w s \sin \theta}{c^2 n (1+n \cos \theta)} \\
 & - \frac{\mathcal{M} \omega R^2 I s \sin \theta}{c^3 n (1+n \cos \theta)^2} + \frac{\mathcal{M} w^3 R \sin \theta}{2c^3} \left[ -\frac{2\dot{r} \cos \theta}{(1+n \cos \theta)^3} \right. \\
 & + \left. \frac{\omega n c \sin \theta}{(1+n \cos \theta)^3} - \frac{2\dot{s} \sin \theta}{(1+n \cos \theta)^3} \right] + \frac{1}{2} p' w R \sin \theta \\
 & \left. + \frac{\mathcal{M} \omega R^2 w \cos \theta}{c (1+n \cos \theta)} + \frac{\mathcal{M} \omega R^2 I \cos \theta}{c^2 (1+n \cos \theta)^2} \right\} d\theta \quad (34)
 \end{aligned}$$

Equations 33 and 34 are non linear in  $n$ . However, with the assumption that the perturbation is small, the equations can be linearized. From Figure XI:

$$c n_0 + r = c n \cos \alpha \approx c n$$

or:

$$n \approx n_0 + \frac{r}{c}$$



where  $\frac{r}{c} \ll n_0$  and is time dependent.

By Taylor's theorem:

$$f(n_0 + \frac{r}{c}) = f(n_0) + \frac{r}{c} f'(n_0)$$

neglecting second order and higher powers of  $\frac{r}{c}$ .

Then, by also neglecting other second order terms:

$$\frac{s}{c} f(n_0 + \frac{r}{c}) \approx \frac{s}{c} f(n_0)$$

$$r f(n_0 + \frac{r}{c}) \approx r f(n_0)$$

$$\frac{r}{c} f(n_0 + \frac{r}{c}) \approx \frac{r}{c} f(n_0)$$

$$s f(n_0 + \frac{r}{c}) \approx s f(n_0)$$

$$\dot{r} s = 0$$

$$\dot{s} s = 0$$

Linearizing the terms of equations 33 and 34 as above:

$$\begin{aligned} dF_r = & \frac{M w^3 R}{2c^3} \cos \theta \left[ - \frac{2\dot{r} \cos \theta}{(1+n \cos \theta)^3} + \frac{W c n \sin \theta}{(1+n \cos \theta)^3} \right. \\ & + \frac{W r \sin \theta (1+n \cos \theta - 3n \cos \theta)}{(1+n \cos \theta)^4} - \left. \frac{2\dot{s} \sin \theta}{(1+n \cos \theta)^3} \right] \\ & + \frac{1}{2} p' w R \cos \theta - \frac{M W R^2 w \sin \theta}{c(1+n \cos \theta)} + \frac{M W R^2 w r \sin \theta \cos \theta}{c^2(1+n \cos \theta)^2} \\ & - \frac{M W R^2 I \sin \theta}{c^2(1+n \cos \theta)^2} + \frac{2 M W R^2 I r n \sin \theta \cos \theta}{c^3(1+n \cos \theta)^3} \end{aligned}$$



$$\left. \begin{aligned} & - \frac{\mathcal{M} w^3 R s \omega \sin^2 \theta}{2c^3 (1 + n \cos \theta)^3} - \frac{p' w R s \sin \theta}{2cn} - \frac{\mathcal{M} W R^2 w s \cos \theta}{c^2 n (1 + n \cos \theta)} \\ & - \frac{\mathcal{M} W R^2 I s \cos \theta}{c^3 n (1 + n \cos \theta)^2} \end{aligned} \right\} d\theta \quad (35)$$

$$\begin{aligned} dF_s = & \left\{ \frac{\mathcal{M} w^3 R s \omega \cos \theta \sin \theta}{2c^3 (1 + n \cos \theta)^3} + \frac{p' s w R \cos \theta}{2cn} - \frac{\mathcal{M} W R^2 w s \sin \theta}{c^2 n (1 + n \cos \theta)} \right. \\ & - \frac{\mathcal{M} W R^2 I s \sin \theta}{c^3 n (1 + n \cos \theta)^2} + \frac{\mathcal{M} w^3 R \sin \theta}{2c^3} \left[ - \frac{2\dot{r} \cos \theta}{(1 + n \cos \theta)^3} \right. \\ & + \frac{W n c \sin \theta}{(1 + n \cos \theta)^3} + \frac{W r \sin \theta (1 + n \cos \theta - 3n \cos \theta)}{(1 + n \cos \theta)^4} \\ & \left. \left. - \frac{2\dot{s} \sin \theta}{(1 + n \cos \theta)^3} \right] + \frac{1}{2} p' w R \sin \theta + \frac{\mathcal{M} W R^2 w \cos \theta}{c(1 + n \cos \theta)} \right. \\ & - \frac{\mathcal{M} W R^2 w r \cos^2 \theta}{c^2 (1 + n \cos \theta)^2} + \frac{\mathcal{M} W R^2 I \cos \theta}{c^2 (1 + n \cos \theta)^2} \\ & \left. - \frac{2\mathcal{M} W R^2 I r \cos^2 \theta}{c^3 (1 + n \cos \theta)^3} \right\} d\theta \quad (36) \end{aligned}$$

Equations 35 and 36 are of the form:

$$dF_r = - dK_{rr} r - dB_{rr} \dot{r} - dK_{rs} s + dB_{rs} \dot{s} + dF_{10}$$

$$dF_s = - dK_{ss} s - dB_{ss} \dot{s} + dK_{sr} r + dB_{sr} \dot{r} + dF_{20}$$

where:

$$\begin{aligned} dK_{rr} = & \left\{ - \frac{\mathcal{M} W w^3 R}{2c^3 (1 + n \cos \theta)} \sin \theta \cos \theta (1 + n \cos \theta - 3n \cos \theta) \right. \\ & \left. - \frac{\mathcal{M} W R^2 w \sin \theta \cos \theta}{c^2 (1 + n \cos \theta)^2} - \frac{2\mathcal{M} W R^2 I \sin \theta \cos \theta}{c^3 (1 + n \cos \theta)^3} \right\} d\theta \quad (37) \end{aligned}$$

$$dB_{rr} = \frac{\mathcal{M} w^3 R \cos^2 \theta}{c^3 (1 + n \cos \theta)^3} d\theta \quad (38)$$



$$dK_{rs} = \left\{ \frac{\mathcal{M}Ww^3R \sin^2 \theta}{2c^3(1+n \cos \theta)^3} + \frac{p'wR \sin \theta}{2cn} + \frac{\mathcal{M}WR^2w \cos \theta}{c^2n(1+n \cos \theta)} + \frac{\mathcal{M}WR^2I \cos \theta}{c^3n(1+n \cos \theta)^2} \right\} d\theta \quad (39)$$

$$dB_{rs} = \frac{\mathcal{M}w^3R \cos \theta \sin \theta}{c^3(1+n \cos \theta)^3} d\theta \quad (40)$$

$$dK_{ss} = -\frac{\mathcal{M}w^3RW \cos \theta \sin \theta}{2c^3(1+n \cos \theta)^3} - \frac{p'wR \cos \theta}{2cn} + \frac{\mathcal{M}WR^2w \sin \theta}{c^2n(1+n \cos \theta)} + \frac{\mathcal{M}WR^2I \sin \theta}{c^3n(1+n \cos \theta)^2} d\theta \quad (41)$$

$$dB_{ss} = \frac{\mathcal{M}w^3R \sin^2 \theta}{c^3(1+n \cos \theta)^3} d\theta \quad (42)$$

$$dK_{sr} = \frac{\mathcal{M}Ww^3R \sin^2 \theta}{2c^3(1+n \cos \theta)} (1+n \cos \theta - 3n \cos \theta) - \frac{\mathcal{M}WR^2w \cos^2 \theta}{c^2(1+n \cos \theta)^2} - \frac{2\mathcal{M}WR^2I \cos^2 \theta}{c^3(1+n \cos \theta)^3} d\theta \quad (43)$$

$$dB_{sr} = -\frac{\mathcal{M}w^3R \sin \theta \cos \theta}{c^3(1+n \cos \theta)^3} d\theta \quad (44)$$

then:

$$K_{mm} = \int_0^{2\pi} dK_{mm}$$

$$B_{mm} = \int_0^{2\pi} dB_{mm}$$

which must be evaluated numerically.

The final result is:

$$F_r = -K_{rr} r - B_{rr} \dot{r} - K_{rs} s + B_{rs} \dot{s} + F_0 \quad (45)$$

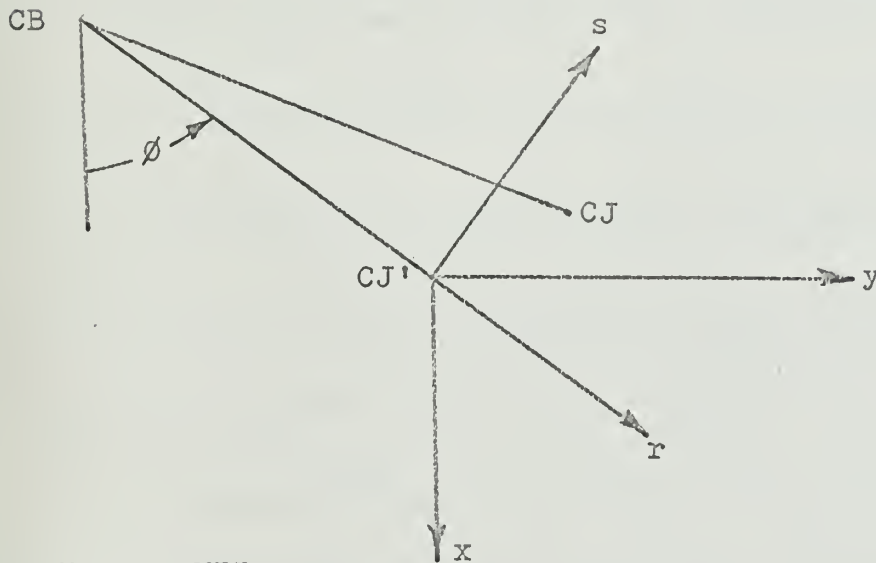




$$F_s = -K_{ss}s - B_{ss}\dot{s} + K_{sr}r + B_{sr}\dot{r} + F_{s0} \quad (46)$$

However, it is generally more convenient to work with cartesian rather than polar coordinates. Therefore the integrated forces, and spring and damping coefficients will be transferred to the  $x - y$  axis as shown in Figure XII.

Figure XII  
Journal motion in  $x - y$  coordinates



From Figure XII:

$$r = y \sin \phi + x \cos \phi \quad (47)$$

$$s = y \cos \phi - x \sin \phi \quad (48)$$

$$\dot{r} = \dot{y} \sin \phi + \dot{x} \cos \phi \quad (49)$$

$$\dot{s} = \dot{y} \cos \phi - \dot{x} \sin \phi \quad (50)$$

$$F_x = F_r \cos \phi - F_s \sin \phi \quad (51)$$

$$F_y = F_r \sin \phi + F_s \cos \phi \quad (52)$$



Equations 47 through 52 are substituted into equations 45 and 46:

$$F_r = -K_{rr}(y \sin \emptyset + x \cos \emptyset) - B_{rr}(\dot{y} \sin \emptyset + \dot{x} \cos \emptyset) + F_{10} \\ - K_{rs}(y \cos \emptyset - x \sin \emptyset) + B_{rs}(\dot{y} \cos \emptyset - \dot{x} \sin \emptyset) \quad (53)$$

$$F_s = -K_{ss}(y \cos \emptyset - x \sin \emptyset) - B_{ss}(\dot{y} \cos \emptyset - \dot{x} \sin \emptyset) + F_{20} \\ + K_{sr}(y \sin \emptyset + x \cos \emptyset) + B_{sr}(y \sin \emptyset + x \cos \emptyset) \quad (54)$$

Substituting equations 53 and 54 into equations 51 and 52:

$$F_x = -K_{rr} \sin \emptyset \cos \emptyset y - K_{rr} \cos^2 \emptyset x - B_{rr} \sin \emptyset \cos \emptyset \dot{y} \\ - B_{rr} \cos^2 \emptyset \dot{x} - K_{rs} \cos^2 \emptyset y + K_{rs} \sin \emptyset \cos \emptyset x \\ + B_{rs} \cos^2 \emptyset \dot{y} - B_{rs} \sin \emptyset \cos \emptyset \dot{x} + F_{10} \cos \emptyset \\ + K_{ss} \cos \emptyset \sin \emptyset y - K_{ss} \sin^2 \emptyset x + B_{ss} \cos \emptyset \sin \emptyset \dot{y} \\ - B_{ss} \sin^2 \emptyset \dot{x} - K_{sr} \sin^2 \emptyset y - K_{sr} \sin \emptyset \cos \emptyset x \\ - B_{sr} \sin^2 \emptyset \dot{y} - B_{sr} \sin \emptyset \cos \emptyset \dot{x} - F_{20} \sin \emptyset \\ F_y = -K_{rr} \sin^2 \emptyset y - K_{rr} \sin \emptyset \cos \emptyset x - B_{rr} \sin^2 \emptyset \dot{y} \\ - B_{rr} \sin \emptyset \cos \emptyset \dot{x} - K_{rs} \sin \emptyset \cos \emptyset y + K_{rs} \sin^2 \emptyset x \\ + B_{rs} \sin \emptyset \cos \emptyset \dot{y} - B_{rs} \sin^2 \emptyset \dot{x} + F_{10} \sin \emptyset \\ - K_{ss} \cos^2 \emptyset y + K_{ss} \sin \emptyset \cos \emptyset x - B_{ss} \cos^2 \emptyset \dot{y} \\ + B_{ss} \sin \emptyset \cos \emptyset \dot{x} + K_{sr} \sin \emptyset \cos \emptyset y + K_{sr} \cos^2 \emptyset x \\ + B_{sr} \sin \emptyset \cos \emptyset \dot{y} + B_{sr} \cos^2 \emptyset \dot{x} + F_{20} \cos \emptyset$$



Then:

$$F_x = -K_{xx}x - B_{xx}\dot{x} - K_{xy}y - B_{xy}\dot{y} - F_0 \quad (55)$$

$$F_y = -K_{yy}y - B_{yy}\dot{y} + K_{yx}x - B_{yx}\dot{x} \quad (56)$$

Where:

$$K_{xx} = K_{rr} \cos^2 \phi + (K_{sr} - K_{rs}) \sin \phi \cos \phi + K_{ss} \sin^2 \phi \quad (57)$$

$$K_{yy} = K_{ss} \cos^2 \phi + (K_{rs} - K_{sr}) \sin \phi \cos \phi + K_{rr} \sin^2 \phi \quad (58)$$

$$K_{xy} = K_{rs} \cos^2 \phi + (K_{rr} - K_{ss}) \sin \phi \cos \phi + K_{sr} \sin^2 \phi \quad (59)$$

$$K_{yx} = K_{sr} \cos^2 \phi + (K_{ss} - K_{rr}) \sin \phi \cos \phi + K_{rs} \sin^2 \phi \quad (60)$$

$$B_{xx} = B_{rr} \cos^2 \phi + (B_{rs} + B_{sr}) \sin \phi \cos \phi + B_{ss} \sin^2 \phi \quad (61)$$

$$B_{yy} = B_{ss} \cos^2 \phi - (B_{rs} + B_{sr}) \sin \phi \cos \phi + B_{rr} \sin^2 \phi \quad (62)$$

$$B_{xy} = B_{sr} \sin^2 \phi + (B_{rr} - B_{ss}) \cos \phi \sin \phi - B_{rs} \cos^2 \phi \quad (63)$$

$$B_{yx} = B_{xy} \quad (64)$$

### Computational Procedure

The general case of unsteady motion of a circular circumferentially grooved journal bearing has now been analyzed and the differential forces and differential spring and damping coefficients are in forms which can be solved numerically. A detailed procedure, using a high speed computer, is given in Appendix B. However, the general computational procedure is as follows. For a given bearing geometry ( $L$ ,  $R$ ,  $C$ , and  $M$ ) and given operating conditions ( $\omega$ ,  $\phi$ ,  $n$  and  $\dot{e}$ ):



1. Determine direction of flow ( $\pm \theta$ ) and locate upstream and downstream cavitation boundaries.
2. For each  $\theta$ , calculate the film width.
3. For each  $\theta$ , determine the differential forces and differential spring and damping constants.
4. Integrate numerically to obtain the radial and tangential forces and spring and damping coefficients.
5. Calculate the bearing load, load angle, and horizontal and vertical spring and damping coefficients.

### Simplified Analysis

It should be noted that equations 37 through 44, and, consequently equations 57 through 64 are independent of  $\dot{e}$ ,  $\dot{\phi}$ ,  $\Delta e$ , and  $\Delta \phi$  due to the fact that (see Figure XI):

$$\left. \frac{dK_{mm}}{d} \right|_{CJ} \equiv \lim_{d \rightarrow 0} \frac{\partial}{\partial d} (dK_{mm} d)$$

$$\left. \frac{dB_{mm}}{dv} \right|_{CJ} \equiv \lim_{v \rightarrow 0} \frac{\partial}{\partial v} (dB_{mm} v)$$

Since  $dK_{mm}$  and  $dB_{mm}$  are functions of  $w$ , then  $w$  must also be independent of  $\dot{\phi}$  and  $\dot{e}$  in the above mentioned equations.

If now frictional effects are neglected on the assumption that they are small compared to squeeze effects, then  $\mathcal{A}$  and  $\mathcal{U}$  can be used interchangeably throughout the entire analysis by virtue of the choice of reference axis. Then the equations for the spring and damping coefficients and the equations for the steady state forces  $F_{10}$  and  $F_{20}$  can be non-dimensionalized and expressed in terms of just three independent variables; eccentricity ratio,  $n$ , pressure ratio,  $PR$ , and dimensionless squeeze,  $\mathcal{A}^*$ . Let:

$$n = \frac{e}{c}$$





$$PR = \frac{p_o}{p_a}$$

$$\mathcal{A}^* = \frac{1}{p} \left( \frac{L}{c} \right)^2$$

Then the pertinent dimensionless equations are:

$$\frac{W}{L} = \sqrt{\frac{-(PR - 1)(1 + n \cos \theta)^3}{3n\mathcal{A}^* \sin \theta}} \quad (65)$$

$$\frac{W}{L^3} \frac{dW}{d\theta} = \left( \frac{W}{L} \right)^3 \frac{1}{2(\cos \theta - \cos \theta^*)} + \frac{(1 + n \cos \theta)^3 (PR - 1)}{6n\mathcal{A}^*(\cos \theta - \cos \theta^*)} \quad (66)$$

$$\frac{dF_{1c}}{p \, LR} = \frac{1}{2} \mathcal{A}^* \left( \frac{W}{L} \right)^3 \frac{\sin \theta \cos \theta}{(1 + n \cos \theta)^3} + \left( \frac{W}{L} \right) (PR - 1) \cos \theta \, d\theta \quad (67)$$

$$\frac{dF_{2c}}{p \, LR} = \frac{1}{2} \mathcal{A}^* \left( \frac{W}{L} \right)^3 \frac{\sin^2 \theta}{(1 + n \cos \theta)^3} + \left( \frac{W}{L} \right) (PR - 1) \sin \theta \, d\theta \quad (68)$$

$$\frac{dK_{rrc}}{p \, LR} = - \frac{\mathcal{A}^*}{2} \left( \frac{W}{L} \right)^3 \frac{\sin \theta \cos \theta}{(1 + n \cos \theta)} (1 + n \cos \theta - 3n \cos \theta) d\theta \quad (69)$$

$$\frac{dK_{rsc}}{p \, LR} = \left[ \frac{\mathcal{A}^*}{2} \left( \frac{W}{L} \right)^3 \frac{\sin^2 \theta}{(1 + n \cos \theta)} + \frac{1}{2n} (PR - 1) \left( \frac{W}{L} \right) \sin \theta \right] d\theta \quad (70)$$

$$\frac{dK_{ssc}}{p \, LR} = \left[ - \frac{\mathcal{A}^*}{2} \left( \frac{W}{L} \right)^3 \frac{\sin \theta \cos \theta}{(1 + n \cos \theta)} + \frac{1}{2n} (PR - 1) \left( \frac{W}{L} \right) \cos \theta \right] d\theta \quad (71)$$

$$\frac{dK_{src}}{p \, LR} = \frac{\mathcal{A}^*}{2} \left( \frac{W}{L} \right)^3 \frac{\sin^2 \theta}{(1 + n \cos \theta)} (1 + n \cos \theta - 3n \cos \theta) \quad (72)$$

$$\frac{dB_{rrc}}{p \, LR} = \mathcal{A}^* \frac{\cos^2 \theta}{(1 + n \cos \theta)^3} \, d\theta \quad (73)$$

$$\frac{dB_{ssc}}{p \, LR} = \mathcal{A}^* \frac{\sin^2 \theta}{(1 + n \cos \theta)^3} \, d\theta \quad (74)$$



$$\frac{dB_{src}}{p_{LR}} = - \int^* \frac{\sin \theta \cos \theta}{(1 + n \cos \theta)^3} d\theta \quad (75)$$

$$dB_{rs} = dB_{sr}$$

The general computational procedure is the same as before, except that all frictional effects are neglected.



## RESULTS

Figures XIII, XIV, XV, XVI and XVII illustrate the shape and extent of the cavitation zone for various combinations of journal motion obtained by this investigation. Results obtained by Ishii and Richardson ( the latter in dashed lines) are also presented for comparison. The direction of the circumferential flow in Figure XVI is the reverse of the circumferential flow in Figure XV, thus Figure XVI is a mirror image of Figure XV.

Tables 1 and 2 show a breakdown of the effects of circumferential squeeze, radial squeeze, feed pressure, complete film friction, and cavitation zone friction on the forces and spring and damping coefficients for the examples in Figures XV and XIV.

Tabulated data for the simplified analysis which neglected frictional effects is given in Appendix C for numerous combinations of dimensionless squeeze, pressure ratio, and eccentricity ratio. The parameters were chosen so as to cover as wide a range of bearing applications as possible.

Table 3 is a comparison between the data in Appendix C and data obtained by Holmes [8] who analyzed the vibration of a rigid shaft by extending Ockvirk's analysis and boundary conditions. The data in Appendix C was converted to Holmes' nomenclature as follows:

$$\frac{c}{2F^*} K_{nm} = K_{NM} \frac{p_a LR}{2F^*}$$

$$\frac{\omega c}{2F^*} B_{nm} = B_{NM} \frac{p_a LR}{2F^*}$$

Where:

$$\frac{F^*}{p_a LR} = * \frac{n \left[ \pi^2 (1 - n^2) + 16n^2 \right]^{\frac{1}{2}}}{4(1 - n^2)^2}$$



which is a form of Ockvirk's load number. The factor of 2 is necessary because this investigation uses a circumferentially grooved bearing with a total length of  $2L$ .

Since Ockvirk's theory defines the attitude angle for a given eccentricity ratio, it was necessary to fix both  $\phi$  and  $n$  in the comparison.

The program in Appendix B is written in a manner so that any or all of the values can be called without any major changes. Frictional effects can be neglected simply by deleting the indicated cards, thus reducing the program to three dimensionless variables as in Appendix C. It should be noted that for simplicity only one half of the bearing was considered in the analysis, but that the program and tabulated data are in terms of the entire bearing length  $2L$ .





Figure XIII  
Cavitation Boundaries

$L = 1$   
 $D = 2$   
 $c = .003$   
 $M = .000002$   
 $p = 25$

$\omega = 375$   
 $\dot{\phi} = 0$   
 $\dot{e} = 0$   
 $n = .4$

Richardson	$\underline{2F_0}$	$\phi$
Ishii	13.9	78.2
This Investigation	15.0	76.3
	14.2	75.4

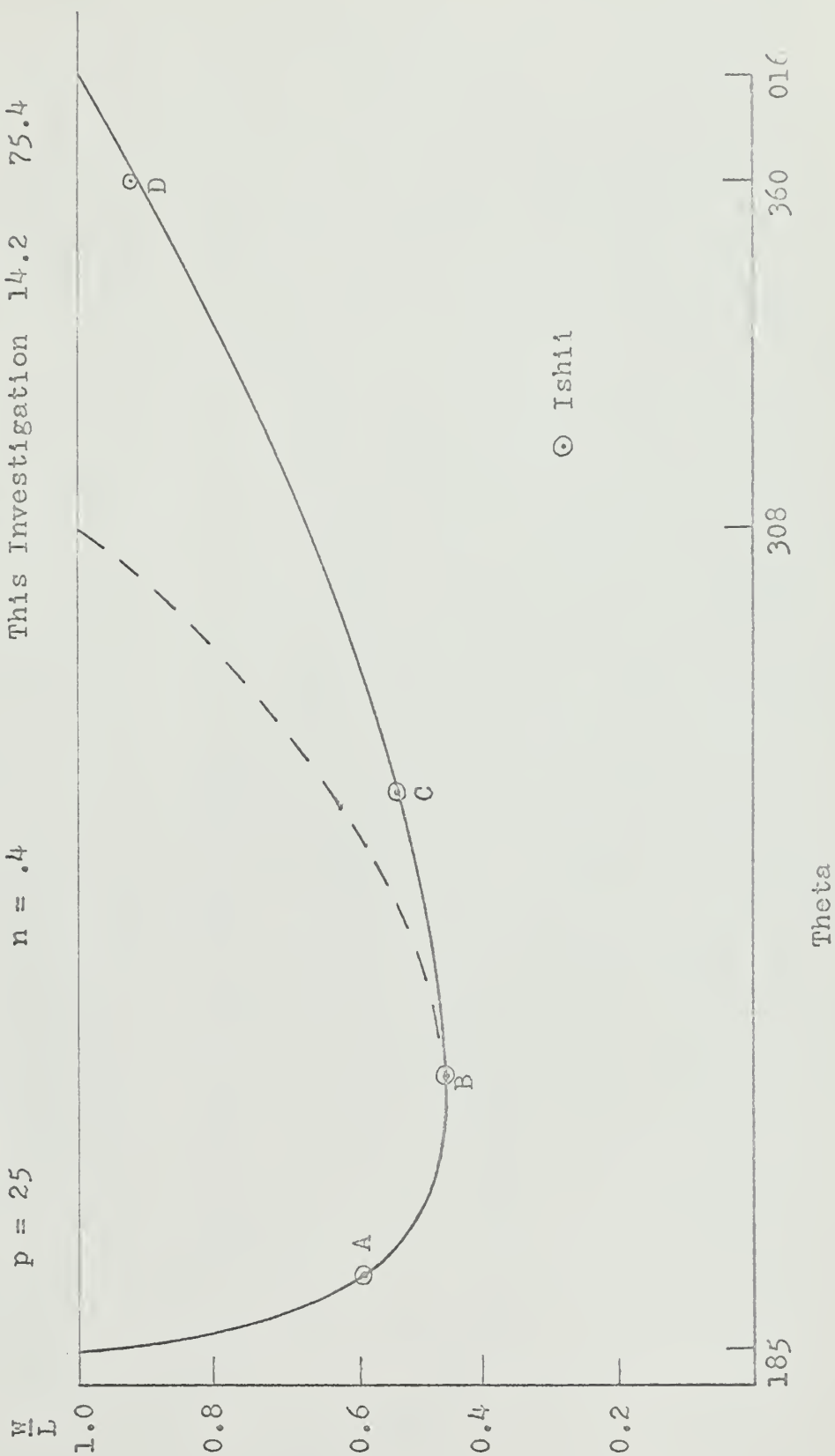




Figure XIV

Cavitation Boundaries

$L = 1$	$\omega = 1200$	Richardson	$\frac{2F_o}{\phi}$	$\phi$
$D = 2$	$\dot{\phi} = 0$		91.6	73.3
$c = .002$	$\dot{e} = 0$	This Investigation	94.0	68.5
$\mathcal{M} = .000002$	$n = .4$			
$p = 60$				

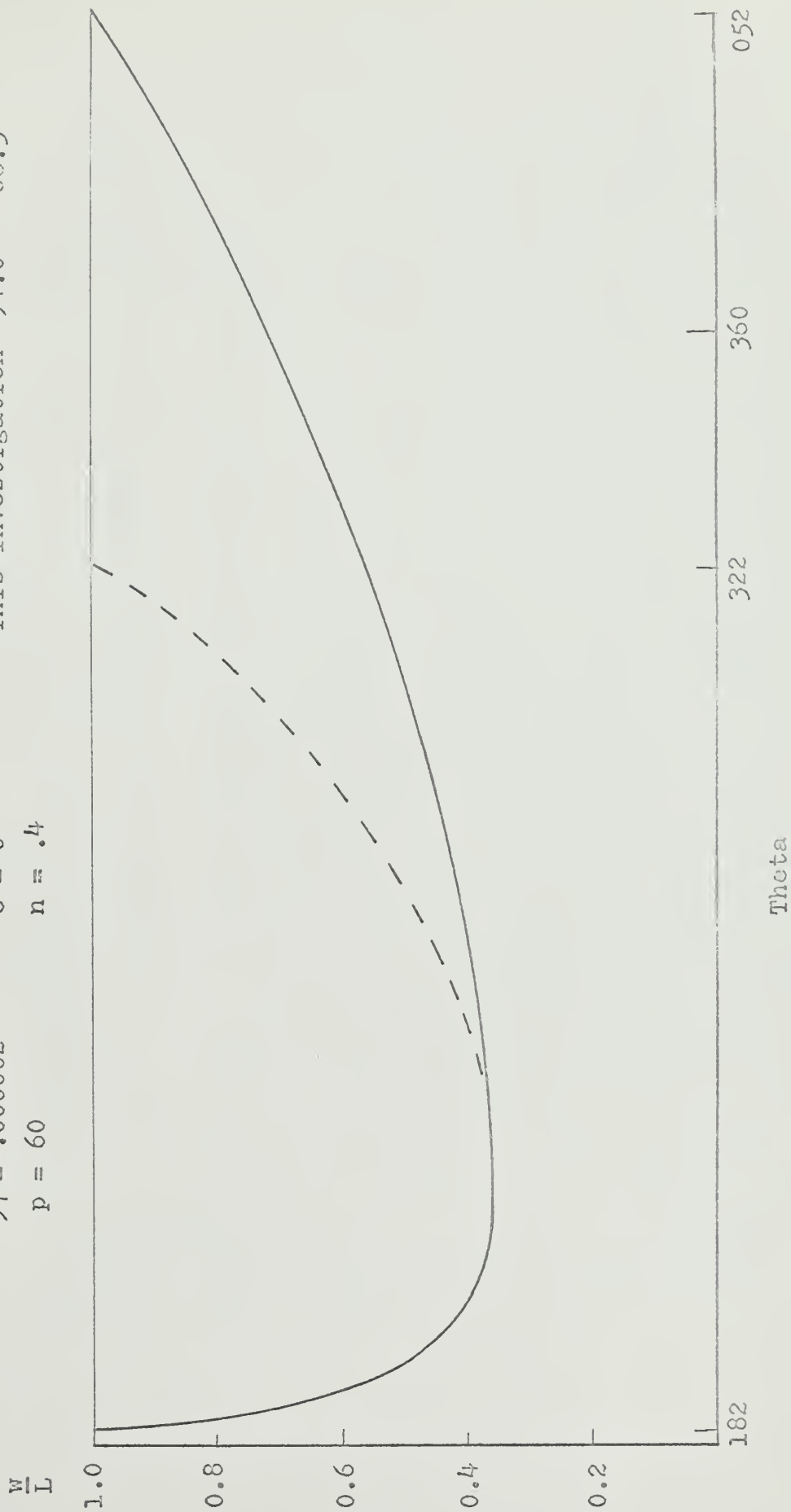




Figure XV

Cavitation Boundaries

$L = 1$	$\omega = 1200$	$\underline{2F_0}$	$\phi$
$D = 2$	$\dot{\phi} = 300$	388.0	7.62
$c = .002$	$\dot{c} = 1$	388.5	7.55
$\mu = .000002$	$n = .4$		
$p = 60$			

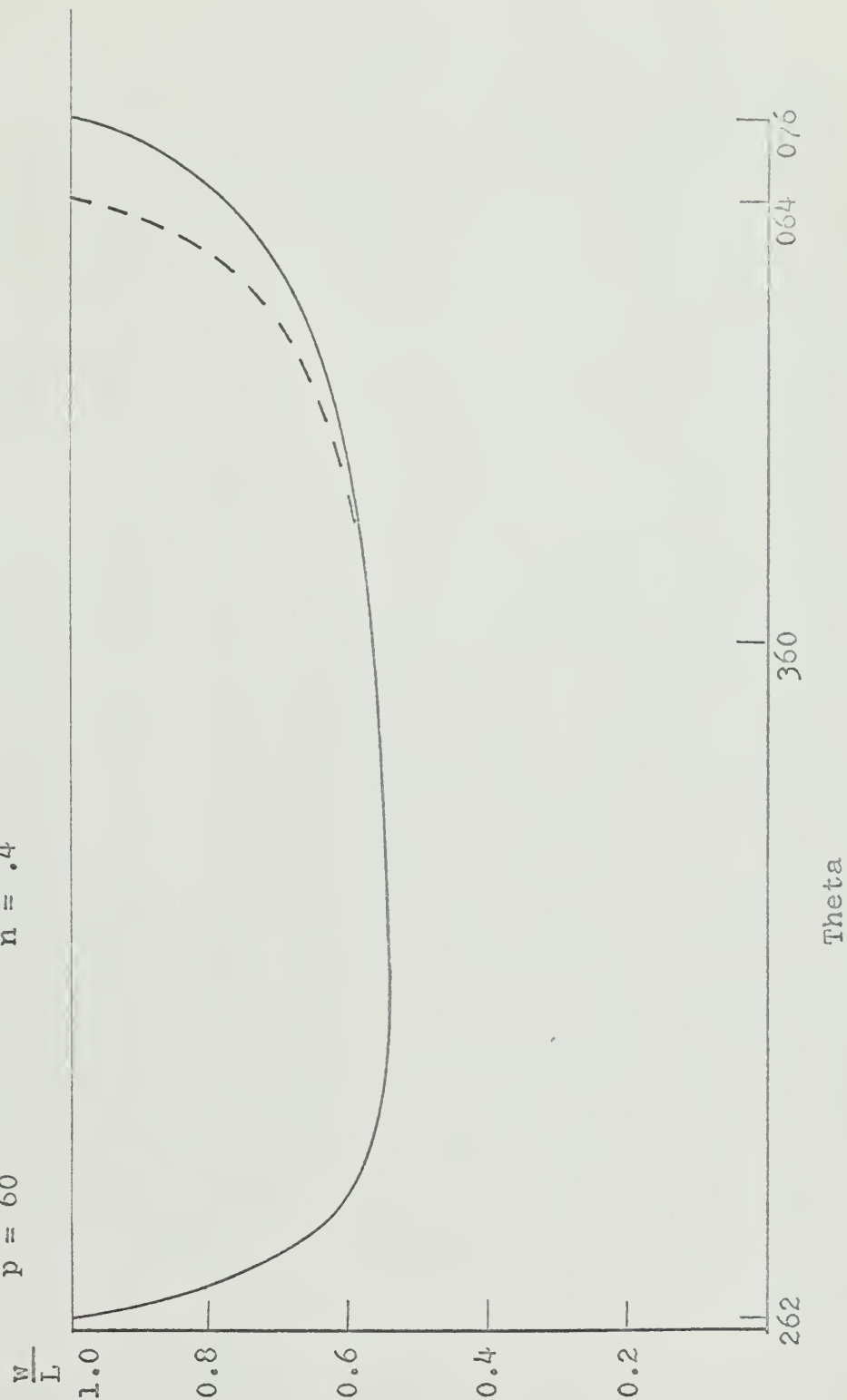




Figure XVI

Cavitation Boundaries

$L = 1$	$\omega = 1200$	$\frac{2F_0}{\rho}$	$\phi$
$D = 2$	$\phi = 900$	388.5	-8.22
$c = .002$	$\dot{e} = 1$	This Investigation	388.7
$\mu = .000002$	$n = .4$		-8.22
$p = 60$			

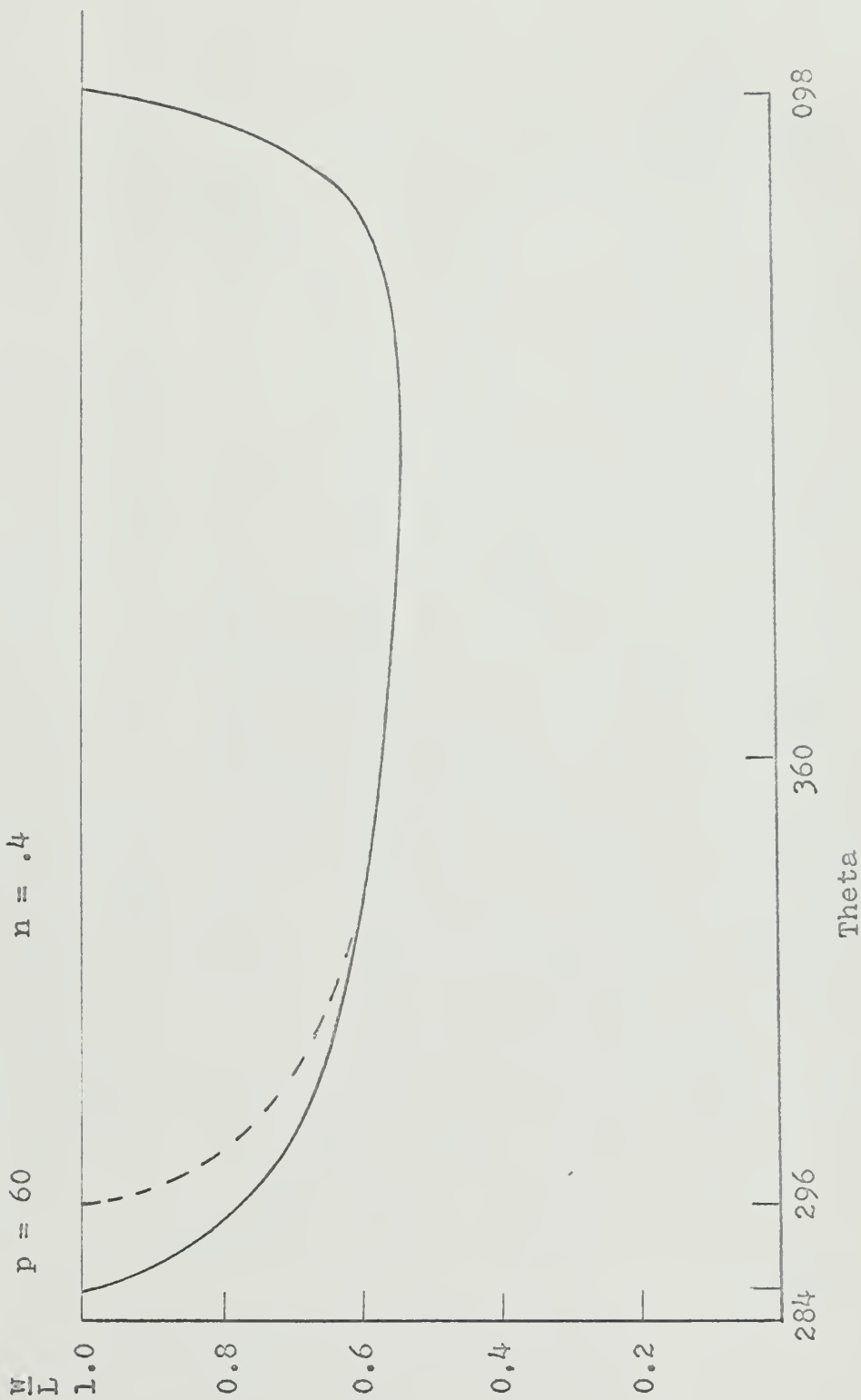






Figure XVII  
Cavitation Boundaries

$L = 1$	$\omega = 1200$	Richardson	$\frac{2F_0}{\phi}$
$D = 2$	$\dot{\phi} = 600$		385.5
$c = .002$	$\dot{e} = 1$	This Investigation	--.03
$\mu = .000002$	$n = .4$		385.5
$p = 60$			--.33

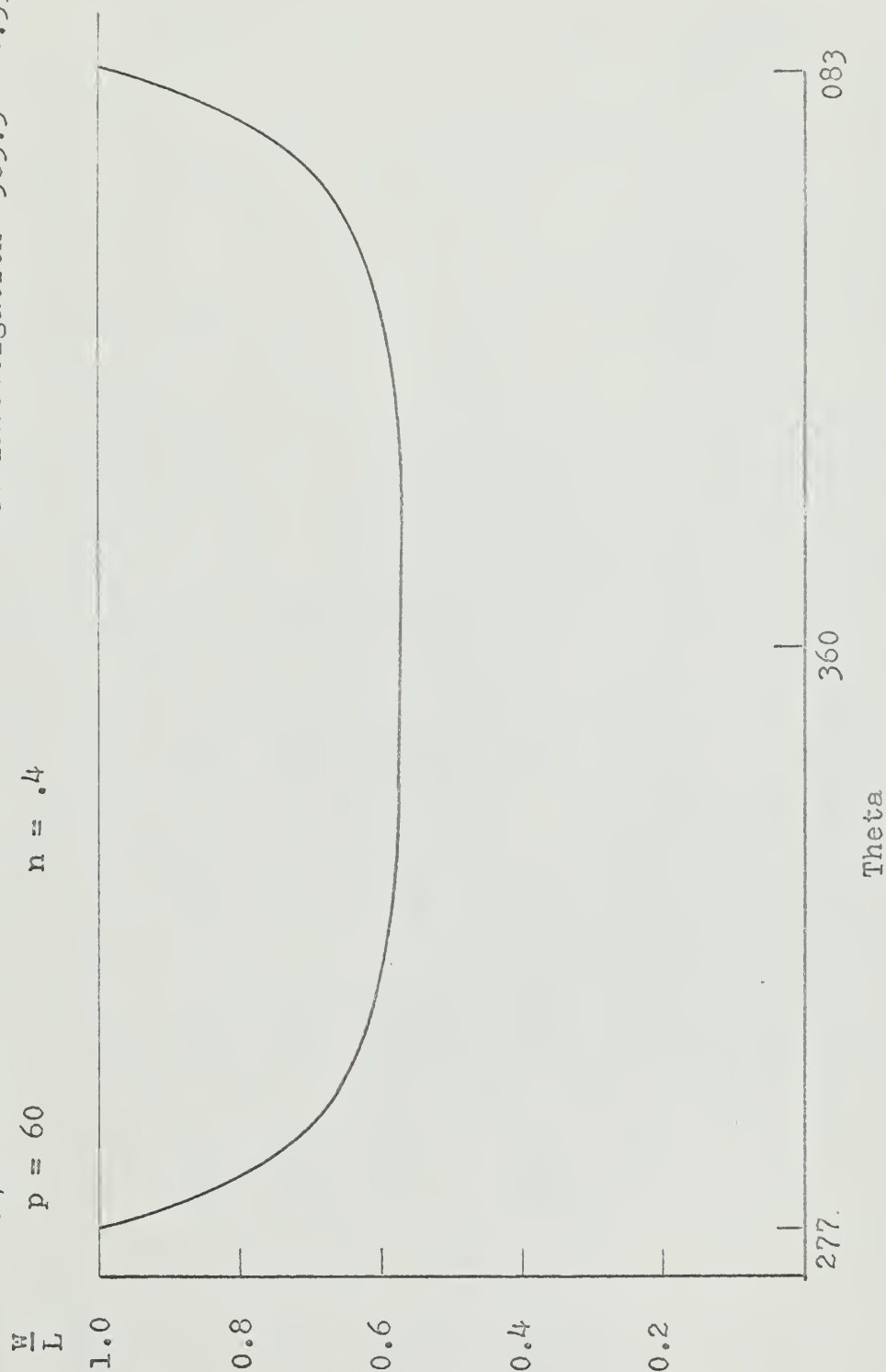




Table 1: Effect of squeeze, pressure and friction on the forces and spring and damping constants of Figure XIV.

Component	$F_r$	$F_s$	$K_{rr}$	$K_{ss}$	$K_{rs}$	$K_{sr}$	$B_{rr}$	$B_{ss}$	$B_{sr}$
Circumfer. squeeze									
Radial squeeze	-33.2	65.0	108000	41400	81200	128000	232	135	69.1
Pressure	.0226	11.9		10.0	190				
Complete film friction	-.698	-.635	272	1740	-1580	-2060			
Cavity zone friction	.0254	-.0198	35.0	-10	-8.0	-46.8			



Table 2: Effect of squeeze, pressure and friction on the forces and spring and damping constants of Figure XV.

Component	$F_r$	$F_s$	$K_{rr}$	$K_{ss}$	$K_{rs}$	$K_{sr}$	$B_{rr}$	$B_{ss}$	$B_{sr}$
Circumfer. squeeze	-362	-3.72	-1290	-2230	.129000	224000	368	215	-3.7
Radial squeeze	.894	51.6							
Pressure	-17.8	5.42		142	43.4				
Complete film friction	-.13	-2.42	-29.8	326	-3040	-2530			
Cavity zone friction	.038	.070	-26.8	-15.0	28.0	-82.4			



Table 3: Comparison of Holmes' results[8] and the results of this investigation.

	n = .2, $\phi = 75$			n = .4, $\phi = 60$			n = .6, $\phi = 46$		
	Holmes	this investigation PR=1.5	PR=3	Holmes	this investigation PR=1.5	PR=3	Holmes	this investigation PR=1.5	PR=3
$\frac{c}{2F_1} K_{rr}$	2.72	2.29	2.27	3.35	3.23	3.17	4.80	4.90	4.87
$\frac{c}{2F_1} K_{ss}$	1.26	1.36	1.36	1.21	1.28	1.31	1.15	1.21	1.21
$\frac{c}{2F_1} K_{sr}$	5.44	5.95	5.85	3.43	3.41	3.26	3.26	3.30	3.20
$\frac{c}{2F_1} K_{rs}$	4.55	5.23	5.20	2.18	2.18	1.97	1.21	1.15	1.15
$\frac{c}{2F_1} B_{rr}$	10.88	13.95	13.10	6.86	7.20	6.87	6.52	6.85	6.70
$\frac{c}{2F_1} B_{ss}$	9.10	10.30	10.20	4.36	4.32	3.83	2.42	2.21	2.24
$\frac{c}{2F_1} B_{rs}$	2.52	2.66	2.49	2.42	2.61	2.56	2.30	2.41	2.39





## DISCUSSION OF RESULTS

For the steady state example of Figure XIII, Ishii's results are very close to the results of this investigation, considering that while Ishii used continuity of flow through the cavity, he averaged the flow leaving the boundary 1 - 2 and then used this average to determine the boundary 2 - 3. Thus it should be expected that Ishii's point C should be outside the boundary of this investigation since the average flow at  $w_c$  is less than the straight line flow, while point D should be inside the boundary of this investigation since the average flow at  $w_D$  is greater than the straight line flow. However,  $h$  does not vary appreciably between point 1 and 2 due to the large slope of the upstream boundary, and thus the average flow throughout the cavity is very close to the exact flow. Also, some minor disagreement could be expected between machine and hand calculations.

The deviation between this theory and Richardson's is quite pronounced along the downstream boundary, particularly in the steady state cases of Figure XIII and XIV; closer agreement is reached as the ratio of circumferential flow to axial flow is reduced as in Figure XV and XVI until there is perfect agreement in Figure XVII where only axial flow due to radial velocity  $\dot{e}$  is present. None of the sample runs indicated any differences along the upstream boundary; this was to be expected since both theories use the same method for calculating the upstream boundary. The values for load and attitude angle are surprisingly close in Figure XVII, considering that different numerical integration techniques were employed for the two theories. Thus any deviations in the results can be attributed directly to the differences between the downstream cavitation boundaries. This is best illustrated in the steady state examples of Figures XIII and XIV, where the most pronounced difference is in the fourth quadrant ( $1.5\pi < \theta < 2\pi$ ).



Richardson's theory yields a greater film extent in this area and consequently a greater film force in the direction of the applied load, thus reducing the net bearing load and increasing the load angle. The same analysis can be applied to the other examples although it is somewhat more complicated in the dynamic cases. Richardson did not compute the spring and damping coefficients and so no direct comparison of these can be made, but by comparing the bearing loads and load angles for the dynamic cases, it can be deduced that the same order of magnitude of differences in the spring and damping coefficients would exist by virtue of equations 45 and 46.

The purpose of Tables 1 and 2 is to show the small effect that friction has on the film forces and spring and damping coefficients, and therefore to justify neglecting friction in the preparation of the dimensionless tables in Appendix C. In general, friction can be neglected in all cases except when  $(\omega - 2\dot{\phi})$  and  $\dot{e}$  are very small, as in half speed whirl.

Table 3 illustrates the effect of the choice of cavitation boundary conditions on the spring and damping coefficients. Using Ockvirk's boundary conditions, Holmes assumes that the entire half of the bearing is cavitating, an assumption which approaches this theory only at the higher eccentricity ratios. Thus there is close agreement at  $n = .6$ , while at  $n = .2$  the two theories yield somewhat different values. At first, it would be expected that this theory should always give less values of  $K_{rr}$ ,  $K_{ss}$ ,  $B_{rr}$ , and  $B_{rs}$  at low eccentricity ratios since these coefficients go to zero in the completely uncavitated situation (see Appendix C), but this is not so because the film and the film forces obtained by this theory are unsymmetrical about  $\theta = 1.5$ , and thus a clear comparison cannot be made. However, by comparing the results of this investigation for a high and a low feed pressure, it can be seen that as the feed pressure increases causing the film extent to increase, the radial spring coefficient decreases.



Sternlicht[13] used Sommerfeld's boundary conditions and digital methods to solve Reynolds' three dimensional equation and to obtain spring and damping coefficients for a full journal bearing. However, no quantitative basis for comparison could be found, although it is significant to note that Sternlicht found the damping cross terms  $B_{xy}$  and  $B_{yx}$  negligible, while this theory and Holmes' analysis found these coefficients to be of the same order of magnitude as  $B_{yy}$  and  $B_{xx}$ .

The general validity of the results can best be ascertained by examining the initial assumptions that were made. Since low to moderately loaded bearings are considered in this investigation, bearing distortion and viscosity variations due to pressure can be neglected. Also the choice of a circumferential groove feeding arrangement reduces the variation of viscosity due to temperature since the oil flow for a line source is three to four times that for other feeding arrangements at any given load.<sup>14</sup> The accuracy of the short bearing approximation is illustrated in Appendix A where the error is negligible for  $L/D = \frac{1}{4}$ , and is acceptable for  $L/D = \frac{1}{2}$ .

The assumptions that undoubtedly need considerably more investigation are those that apply to the flow of the fluid through the cavity, under dynamic conditions, particularly where the striations join the downstream boundary. The steady state investigations(referenced in the Introduction) using transparent bearings have shown a finite and irregular distribution of striations, with the result that considerable mixing must occur at the downstream boundary, and thus in actuality the downstream boundary cannot be precisely defined mathematically. Also, because of the low pressure gradients immediately surrounding the boundary, surface tension and wettability probably influence the shape of the boundary.

The other assumptions that were made such as laminar flow, Newtonian fluid, etc., are generally accepted and will not be discussed in this paper.





## CONCLUSIONS AND RECOMMENDATIONS

This investigation has analyzed and programmed the unsteady motion of a circular, circumferentially grooved journal bearing. The results should prove useful in designing the particular type of bearing considered, while the analytical and computational methods employed can be modified for application to other bearing configurations. The most important point that was brought out by this investigation was that neglecting the oil film between  $\theta = \pi$  and  $\theta = 2\pi$  will not yield good values for the spring and damping coefficients in lightly loaded high speed bearings, where Ockvirk's theory that a given load establishes the attitude angle is invalid. Conversely, it would be expected that assuming a complete film in that region would also give poor results with the exception of hydrostatic bearings.

Recommendations for future work in the subject area of this investigation are listed below.

1. Devise and construct an experimental apparatus to measure dynamic forces and load angles, with sufficient accuracy to establish the validity of the boundary conditions of this investigation as compared to Ockvirk's boundary conditions.
2. Extend Richardson's theory and his program to obtain the spring and damping coefficients. If the differences are relatively small, Richardson's analysis would be preferable due to the simplicity of his boundary conditions; in its general form it could more readily be modified for various particular analysis such as half speed whirl, stability, vibrations, etc.
3. For use with  $L/D > \frac{1}{2}$ , program Reynolds' three dimensional equation using the boundary conditions of continuity.





## APPENDICES

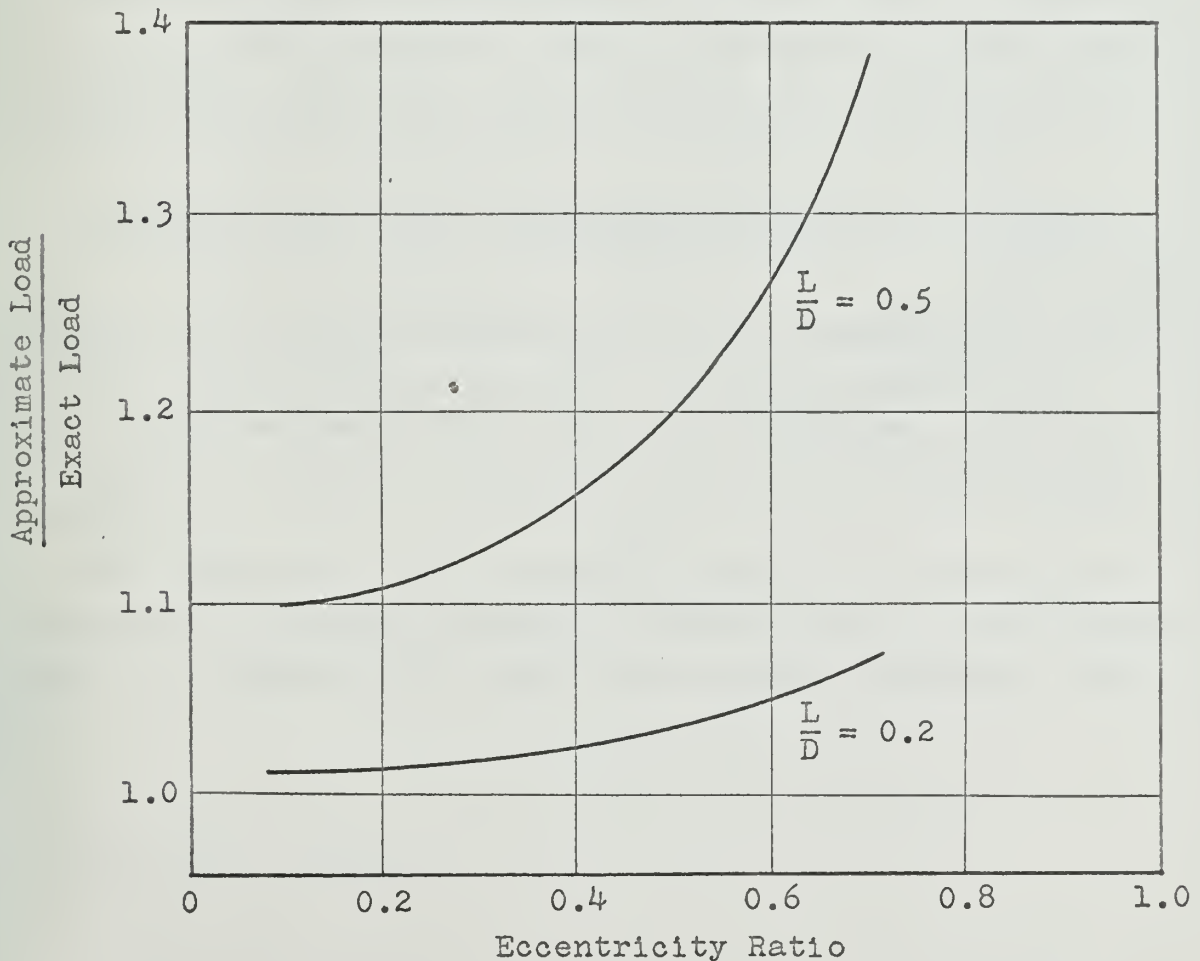


## APPENDIX A

### Accuracy of the Short Bearing Approximation

Donaldson[?] obtained an exact solution to Reynolds' equation for a journal bearing using series solutions and applying Sommerfeld's boundary conditions, but he assumed that the feed pressure was sufficiently high to suppress cavitation. Figure XVIII is a comparison of Donaldson's solution and the results of this investigation, using data for uncavitated bearings from Appendix C. Two length to diameter ratios are plotted as a function of eccentricity ratio versus the ratio of approximate to exact load capacity.

Figure XVIII





## APPENDIX B

### Computational Procedure

The analysis was programmed in Fortran II for use on the IBM 7094 digital computer. The program in its present form can be used either as a main program or as a subroutine by the insertion of the proper administrative and format statements. A sufficient number of comment statements is in the program to permit someone who is familiar with the language to follow the logic, but some of the detailed computational methods need further explanation.

It can be seen in Figure VIII that as the circumferential flow becomes much less than the axial flow that the downstream boundary conditions approach the upstream boundary conditions, and equation 22 applies throughout. If the flow is negative, i.e.,  $(\omega - 2\dot{\phi})$  is negative, then the positions of the upstream and downstream boundaries are reversed. To determine which condition prevailed, the following expression was used:

$$\text{Velocity Ratio (VR)} = \frac{\text{circumferential flow}}{\text{axial flow}} \sim \frac{\Delta n_c}{|\Delta n_c| + |\dot{\phi}|}$$

This gave not only the direction of the circumferential flow, but also its relative magnitude. If VR was positive, all iterations were done in the positive  $\theta$  direction, and if VR was negative, then all iterations were done in the negative  $\theta$  direction.

The beginning of the upstream boundary was obtained by iterating in 3 degree intervals, starting at  $\theta = \pi$  and calculating  $w$  by equation 22, until the following conditions were met:

1.  $w(I) < L$
2.  $w(I) < w(I-1)$



If these conditions were not satisfied when the program had iterated through  $2\pi$ , then a non-cavitated solution was obtained by means of definite integrals (see Appendix D).

If cavitation was present, then  $\theta_2$  was located by iterating in one degree intervals starting at  $\theta_1$ , again calculating  $w$  by equation 22, until  $w(I) > w(I-1)$  i.e., the sign of the slope of the cavitation boundary changed. This established  $\theta_2$ . One degree intervals were used between  $\theta_1$  and  $\theta_2$  so that greater accuracy could be obtained in calculating  $h^*$  later in the program.

Then, starting again at  $\theta_1$  or  $\theta_1 + 3^\circ$ , whichever was even, the program was iterated in 6 degree intervals using equation 22 to calculate the film width along the upstream boundary, and equation 27 to calculate the film width along the downstream boundary. Equation 27 was applied as follows:

1. Assume that  $w(I) = w(I-1)$
2. Determine  $h^*$  by iterating through the  $w$ 's previously calculated between  $\theta_1$  and  $\theta_2$ , until  $w^* > w(I)$ . then interpolate between the stored values of  $\theta^*$  on either side of  $w(I)$  to obtain  $h^*$ .
3. Calculate the slope  $\frac{dw}{d\theta}$  by means of equation 27, using  $h^*(I-1)$  and  $w(I-1)$ .
4. Then,  $w(I) \approx w(I-1) + \frac{dw}{d\theta} \Delta\theta$

However, because equation 27 becomes invalid, both mathematically and analytically, as  $\lambda \rightarrow 0$ , and because the quantity  $(h-h^*)$  becomes very small and practically impossible to calculate digitally with any accuracy as  $VR \rightarrow 0$ , it was necessary to apply certain restrictions along the downstream boundary. These were:





1. If  $|VR| \geq .25$ , equation 27 applied.
2. If  $|VR| < .25$ , equation 22 applied.

The number .25 was obtained by trial and error; as VR approached this value, the downstream boundaries by equations 22 and 27 agreed very closely (Figures XV and XVI have VR values of .33 and -.33 respectively). At lower values of VR, this program gave inconsistent results for the reasons mentioned.

For each  $\theta$ , the differential forces and coefficients were calculated by equations 28 and 28 and equations 37 through 44. The integral of  $h^*dz$  for use in calculating the frictional forces in the cavitated zone was evaluated by Simpson's Rule using 3 ordinates:

$$\int_w^L h^*dz \approx \frac{1}{6} (h^* - h^*)(w^* - 4w_{ave} + w)$$

Then the differential forces and coefficients were integrated from  $\theta = \pi$  to  $\theta = 3\pi$ , by means of the subroutine, which uses Simpson's Rule and 61 ordinates. For clarity, each component of each equation was calculated separately; thus DCSS1 is the first term of  $dK_{ss}$ .

The remainder of the program is self explanatory. It should be noted though that FR is the radial force directed inward; this was changed for conventions sake.



# ANALYSIS OF A CIRCUMFERENTIALLY GROOVED JOURNAL BEARING

INPUT IS TOTAL BEARING LENGTH, JOURNAL RADIUS, RADIAL CLEARANCE,  
 ANGULAR SPEED, ORBITAL SPEED, RADIAL VELOCITY, ECCENTRICITY RATIO,  
 ABSOLUTE FEED PRESSURE, AND VISCOSITY (EL, R, C, OM, PHIDOT, DE, EN, PO, U)  
 UNITS ARE LB, IN, SEC, RADIANS

OUTPUT IS RADIAL, TANGENTIAL, HORIZONTAL, AND VERTICAL BEARING FORCES  
 SPRING COEFFICIENTS, AND DAMPING COEFFICIENTS (FR, FT, FTOT, ANG, CRR,  
 CSS, CSR, CNS, CRR, BSS, BRS, CXX, CYY, CYX, CXY, BXX, BYY, BXY,)

DIMENSION X2(99), W2(99), X(61), W(61), DF11(61), DF12(61), DF13(61),  
 1DF14(61), DF21(61), DF23(61), DF24(61), DCRR1(61), DCRR2(61), DCSR1(61),  
 2DCSR2(61), AHSDZ(61), DCRR3(61), DCSR4(61), DCSS4(61), DCSR3(61),  
 3CF15(61), DF25(61), W1(124)

COMBINE AND REDUCE INPUT

GA=OM-2.0\*PHIDOT  
 P=PO-15.0  
 PI=3.1416  
 EE = 0.5\*EL  
 GG = (0.5\*EL)\*\*3  
 CC=(U\*R)/(2.0\*C\*\*3)  
 DD=(U\*OM\*R\*\*2)/C  
 SS=DD/C  
 TT=CC\*OM

BS=0.  
 BW=0.  
 BP=0.  
 BE=0.  
 BR=0.  
 BS=0.  
 BT=0.  
 BU=0.  
 BV=0.  
 BY=0.  
 AHSDZ=0.

MAGNITUDE AND DIRECTION OF CIRCUMFERENTIAL FLOW

VR=GA/(ABSF(GA)+ABSF(DE/(EN\*C)))  
 IF(VR) 210,110,110

LOCATE X1 FOR NEGATIVE FLOW BY ITERATING IN 3 DEG INTERVALS IN  
 NEGATIVE THETA DIRECTION, BEGINNING AT 5 PI

210 DO 220 K=1,124  
 IF(K-124) 211,300,999  
 211 A=K  
 K=K  
 X1=5.\*PI+.05235-(A\*.05235)  
 AH1S=C\*(1.0+EN\*COSE(X1))



AAA=CCSF(X1)  
BBB=SINF(X1)

EQUATION 20

PH=.1875\*U\*EL\*\*2\*(-2.0\*DE\*AAA+GA\*EN\*C\*BBB)/(C\*(1.0+EN\*AAA))\*\*3  
IF(4.0\*PH+P) 212,215,215

EQUATION 22

212 W1(K)=SQRTF(-((C\*(1.0+EN\*AAA))\*\*3\*P)/(3.0\*U\*((-2.0\*DE\*  
1AAA)+(GA\*EN\*C\*BBB))))

IF(K-1) 999,220,213

213 IF(W1(K-1)-.499\*EL) 220,214,214

214 IF(W1(K)-W1(K-1)) 240,220,220

215 W1(K)=0.5\*EL

220 CONTINUE

LOCATE X2 FOR NEGATIVE FLOW BY ITERATING IN ONE DEG INTERVALS IN  
NEGATIVE THETA DIRECTION , BEGINNING AT X1

240 DO 250 J=1,99

J=J

241 A=J

X2(J)=X1-(A\*.01745)

EQUATION 22

OW2(J)=SQRTF(-((C\*(1.0+EN\*CCSF(X2(J))))\*\*3\*P)/(3.0\*U\*((-2.0\*DE \*  
1CCSF(X2(J)))+(GA\*EN\*C\*SINF(X2(J))))))

IF(J-3) 250,250,245

245 IF(W2(J)-W2(J-3)) 250,251,251

250 CONTINUE

251 WW2=W2(J-3)

XX2=X2(J-3)

JJ=J-12

I=61-K/2

GO TO 153

LOCATE X1 FOR POSITIVE FLOW BY ITERATING IN 3 DEG INTERVALS IN  
POSITIVE THETA DIRECTION,BEGINNING AT 3 PI

110 DO 120 K=1,124

IF (K-124) 111,300,999

111 A=K

K=K

X1=3.0363+(A\*.05235) +2.0\*PI

AH1S=C\*(1.0+EN\*CCSF(X1))

AAA=CCSF(X1)

BBB=SINF(X1)

EQUATION 20

PH=.1875\*U\*EL\*\*2\*(-2.0\*DE\*AAA+GA\*EN\*C\*BBB)/(C\*(1.0+EN\*AAA))\*\*3  
IF(4.0\*PH+P) 112,115,115



## EQUATION 22

```

112 W1(K)=SQRTF(-((C*(1.0+EN*AAA))*3*P)/(3.0*U*((-2.0*DE*
113 1AAA)+(GA*EN*C*BBB))))
      IF(K-1) 999,120,113
113 IF(W1(K-1)-.499*EL) 120,114,114
114 IF(W1(K)-W1(K-1)) 140,120,120
115 W1(K)=0.5*EL
120 CONTINUE

```

LOCATE X2 FOR POSITIVE FLOW BY ITERATING IN ONE DEG INTERVALS IN POSITIVE THETA DIRECTION , BEGINNING AT X1

```

140 DO 150 J=1,99
      J=J
141 A=J
      X2(J)=X1+(A*.01745)

```

## EQUATION 22

```

OW2(J)=SQRTF(-((C*(1.0+EN*COSF(X2(J))))*3*P)/(3.0*U*((-2.0*DE *
1COSF(X2(J)))+(GA*EN*C*SINF(X2(J))))))
      IF(J-3) 150,150,145
145 IF(W2(J)-W2(J-3)) 150,151,151
150 CONTINUE
151 WW2=W2(J-3)
      XX2=X2(J-3)
      JJ=J-12
      I=K/2
      IF(2*I-K) 152,153,999
152 I=I+1

```

INCREMENT IN 6 DEGREE INTERVALS AROUND THE JOURNAL BEGINNING AT X1(IF X1 EVEN) OR AT X1+3(IF X1 ODD)

```

153 DO 170 N=1,61
      A=I
      X(I)=3.0*PI-.1047+(A*.1047)
      AAA=COSF(X(I))
      BBB=SINF(X(I))

```

IF RELATIVE MAGNITUDE OF CIRCUMFERENTIAL FLOW IS SMALL,  
EQUATION 22 APPLYS THROUGHOUT

```

      IF(ABSF(VR)-.25) 154,159,159
159 IF(VR) 2604,1604,1604
2604 IF(XX2-X(I)) 154,154,166
1604 IF(XX2-X(I)) 166,154,154

```

## EQUATION 20

```

154 PH=.1875*U*EL**2*(-2.0*DE*AAA+GA*EN*C*BBB)/(C*(1.0+EN*AAA))*3
      IF(4.0*PH+P) 165,167,167

```





UPSTREAM W (EQUATION 22)

```
165  W(I)=SQRT(-((C*(1.0+EN*AAA))**3*P)/(3.0*U*((-2.0*DE*AAA)+(GA*EN
1  *C*BBB))))
    AHS=C*(1.0+EN*AAA)
    XS=X(I)
    GO TO 168
```

DOWNSTREAM W IS COMPUTED FROM STATEMENT 166 THROUGH 1667

```
166  IF(VR) 11,15,15
11   IF(I-61) 12,13,999
12   W(I)=W(I+1)
    GO TO 20
13   W(I)=W(1)
    GO TO 20
15   IF(I-1) 999,16,17
16   W(I)=W(61)
    GO TO 20
17   W(I)=W(I-1)
```

F\* FOR EQUATION 27

```
20   DO 1664 J=1,JJ
    IF(J-JJ) 36,165,999
36   IF(W(I)-W2(J)) 1664,1661,1661
1661 IF(J-1)999,1662,1663
1662 XS=X2(J)
    GO TO 1665
1663 XS=X2(J-1)+(W(I)-W2(J-1))*(X2(J)-X2(J-1))/(W2(J)-W2(J-1))
    GO TO 1665
1664 CONTINUE
1665 AHS=C*(1.0+EN*COSF(XS))
    AH=C*(1.0+EN*AAA)
```

EQUATION 27

```
    DW=(0.5*W(I)*(-2.0*DE*AAA+GA*EN*C*BBB)+((AH**3*P)/(6.0*U*W(I)))) /
1  (CA*(AH-AHS))
1667 W(I)=W(I)+ABSF(DW)*.1047
```

```
59   IF(W(I)-EL*0.5) 168,167,167
167   W(I)=0.5*EL
168   AA=(1.0+EN*AAA)**3
    ED=W(I)**3
    QQ=(1.0+EN*AAA)**2
    RR=QQ**2
    YW=(1.0+EN*AAA)**2
```

DIFFERENTIAL FUNCTIONS OF FILM WIDTH AND TRIGONOMETRIC FUNCTIONS  
IN CAVITATED ZONE

REMOVE ALL CARDS DOWN TO 1683 IF FRICTIONAL EFFECTS ARE TO BE  
NEGLECTED.

```
1682 AHSDZ=0.
    IF(.49*EL-W(I)) 1683,1683,1671
1671 AH12S=AH1S+(AHS-AH1S)/2.0
    CDD=((AH12S/C)-1.0)/EN
```



X12=ACOSF(DDD)  
 EEE=SINF(X12)

EQUATION 20

PH=.1875\*U\*EL\*\*2\*(-2.0\*DE\*DDD+GA\*EN\*C\*EEE)/(C\*(1.0+EN\*DDD))\*\*3  
 IF(4.0\*PH+P) 1673,1672,1672

1672 ECE=-EEE

EQUATION 22

1673 W12=SQRTF(-(C\*(1.0+EN\*DDD))\*\*3\*P)/(3.0\*U\*((-2.0\*DE\*DDD)+(GA\*EN  
 1\*C\*EEE))))

EQUATION 22

WS=SQRTF(-(C\*(1.0+EN\*COSF(XS))\*\*3\*P)/(3.0\*U\*((-2.0\*DE\*  
 1COSF(XS))+(GA\*EN\*C\*SINF(XS)))))

SSS=ABSF((AHS-AHS)/2.0)  
 AHSDZ=(SSS/3.0)\*(W1(K)+4.0\*W12+WS)

1683 CCRR3(I)=AHSDZ\*BBB\*AAA/AA  
 CCRS4(I)=AHSDZ\*AAA/QQ  
 CCSS4(I)=AHSDZ\*BBB/QQ  
 CCSR3(I)=AHSDZ\*AAA\*\*2/AA  
 CF15(I)=AHSDZ\*BBB/QQ  
 CF25(I)=AHSDZ\*AAA/QQ

DIFFERENTIAL FUNCTIONS OF FILM WIDTH AND TRIGONOMETRIC FUNCTIONS  
 IN COMPLETE FILM ZONE

CF11(I)=(BB\*AAA\*\*2)/AA  
 CF12(I)=(BB\*AAA\*BBB)/AA  
 CF13(I)=W(I)\*AAA  
 CF14(I)=W(I)\*BBB/(1.0+EN\*AAA)  
 CF22(I)=(BB\*BBB\*\*2)/AA  
 CF23(I)=W(I)\*BBB  
 CF24(I)=W(I)\*AAA/(1.0+EN\*AAA)  
 CCRR1(I)=BB\*BBB\*AAA\*\*2/RR  
 CCRR2(I)=W(I)\*AAA\*BBB/QQ  
 CCSR1(I)=BB\*BBB\*\*2\*AAA/RR  
 CCSR2(I)=W(I)\*AAA\*\*2/QQ  
 IF(.49\*EL-W(I)) 1685,1685,420

420 M=174+6\*I  
 IF(M-360) 422,422,421  
 421 M=M-360  
 422 ZZ=2.0\*W(I)/EL

INSERT PRINT STATEMENT HERE IF THETA AND FILM WIDTH(PER CENT) IN  
 CAVITATED REGION IS DESIRED.

1685 IF(VR) 1686,1688,1688  
 1686 I=I-1  
 IF(I) 999,1687,170  
 1687 I=61  
 GO TO 170  
 1688 I=I+1  
 IF(I-62) 170,1689,999  
 1689 I=1



INTEGRATE FUNCTIONS OF FILM WIDTH AND DIFFERENTIAL TRIGONOMETRIC  
FUNCTIONS, USING SIMPSONS RULE

EA =SIMP(DF11)  
EC = SIMP(DF12)  
ED = SIMP(DF13)  
EG = SIMP(DF12)  
EH = SIMP(DF13)  
ER=SIMP(DCRR1)  
EV=SIMP(DCSR1)

DELETE NEXT 10 CARDS IF FRICTIONAL EFFECTS ARE TO BE NEGLECTED

BW=SIMP(DCSR2)  
BS=SIMP(DCRR1)  
EE = SIMP(DF14)  
EP = SIMP(DF24)  
ER=SIMP(DCRR3)  
ES=SIMP(DCRS4)  
ET=SIMP(DCSS4)  
EU=SIMP(DCSR3)  
EV=SIMP(DF15)  
EY=SIMP(DF25)

COMPONENTS OF EQUATIONS 28,29,AND 37-44

F11=-2.0\*CC\*DE\*BA  
F12=CC\*GA\*EN\*C\*BC  
F13=0.5\*P\*R\*BD  
F14=-DD\*BE  
F15=-SS\*DV  
F21=-2.0\*CC\*DE\*BC  
F22=CC\*GA\*EN\*C\*BG  
F23=0.5\*P\*R\*BH  
F24=DD\*BP  
F25=SS\*DY  
CRR1=TT\*(BC-3.0\*EN\*BR)  
CRR2=SS\*BS  
CRR3=2.0\*SS\*DR/C  
BRR=-2.0\*CC\*BA  
CRS1=-TT\*BG  
CRS2=-P\*R\*BH/2.0\*C\*EN  
CRS3=-SS\*BP/EN  
CRS4=-SS\*DS/C\*EN  
BRS=-2.0\*CC\*BC  
CSS1=TT\*DC  
CSS2=P\*R\*BD/2.0\*C\*EN  
CSS3=-SS\*BE/EN  
CSS4=-SS\*DT/C\*EN  
BSS=-2.0\*CC\*BG  
CSR1=TT\*(BG-3.0\*EN\*BV)  
CSR2=-SS\*BW  
CSR3=-2.0\*SS\*DU/C  
BSR=-2.0\*CC\*BC

GO TO 350



FORCES AND SPRING AND DAMPING CONSTANTS IF NO CAVITATION

```

300 PRINT 912
AI=-PI*EN/(1.0-EN**2)**2.5
AG=(3.14/EN)*(1.0-(1.0/(1.0-EN**2)**0.5))
AC = 1.57/(1.0-EN**2)**1.5
F11=0.
F12=-0.0
F13=-0.0
F14=0.
F15=0.
F21=0.
F22=CC*GA*GG*EN*2.0*AC*C
F23=0.0
F24=0.
F25=0.
CRR1=0.
CRR2=0.
CRR3=0.0
BRR=0.0
CRS1=-GG*TT*2.0*AC
CRS2=0.0
CRS3=-(SS*EE/EN)*2.0*AG
CRS4=0.0
BRS=0.0
CSS1=0.0
CSS2=0.0
CSS3=0.0
CSS4=0.0
BSS=-GG*4.0*CC*AC
CSR1=GG*TT*(AC-3.0*EN*AI)
CSR2=0.0
CSR3=0.0
BSR=0.0

350 FR=-2.0*(F11+F12+F13+F14+F15)/(7.5*EL*R)
FI=2.0*(F21+F22+F23+F24+F25)/(7.5*EL*R)
FIOT=SQRTF(FI**2+FR**2)
PHI=ATANF(FI/FR)
ANG=57.3*PHI
CRR=-2.0*(CRR1+CRR2+CRR3)*C/(7.5*EL*R)
CRS=-2.0*(CRS1+CRS2+CRS3+CRS4)*C/(7.5*EL*R)
CSS=-2.0*(CSS1+CSS2+CSS3+CSS4)*C/(7.5*EL*R)
CSR=2.0*(CSR1+CSR2+CSR3)*C/(7.5*EL*R)
BRR=-2.0*BRR*OM*C/(7.5*EL*R)
BSS=-2.0*OM*C/(7.5*EL*R)
BRS=2.0*BRS*OM*C/(7.5*EL*R)
AAA=COSF(PHI)**2
BBB=SINF(PHI)**2
CCC=COSF(PHI)*SINF(PHI)
CXX=CRR*AAA+(CSR-CRS)*CCC+CSS*BBB
CYY=CRR*BBB+(CRS-CSR)*CCC+CSS*AAA
CXY=CRS*AAA+(CRR-CSS)*CCC+CSR*BBB
CYX=CRS*BBB+(CSS-CRR)*CCC+CSR*AAA
BXX=BRR*AAA+2.0*BRS*CCC+BSS*BBB
BYY=BRR*BBB-2.0*BRS*CCC+BSS*AAA
BXY=BRR*CCC-BRS*AAA-BSS*CCC+BRS*BBB

```

```

999 CALL EXIT
END

```





FORTRAN

SIMPSONS RULE FOR 61 ORDINATES, WITH 6 DEGREE INTERVALS

```
FUNCTION SIMP(Y)
DIMENSION Y(61)
ODD=0.
EVEN=0.
DO 800 I=2,60,2
800  EVEN=EVEN+Y(I)
DO 810 I=3,59,2
810  ODD=ODD+Y(I)
SIMP=(.1047/3.0)*(Y(1)+4.0*EVEN+2.0*ODD+Y(61))
RETURN
END
DATA
```



### APPENDIX C

#### Tabulated Values of Bearing Load, Attitude Angle, And Spring and Damping Constants

Tables 4 through 45 contain values of dimensionless load, load angle, and dimensionless spring and damping constants as a function of eccentricity ratio, pressure ratio, and dimensionless squeeze. The eccentricity is in increments of 0.1 from 0.1 to 0.7, the latter being chosen as the upper limit in order to remain within the limits of the short bearing approximation, the assumption of constant viscosity, and the assumption of no journal or bearing distortion. The pressure ratios are 1.5, 2.0, 3.0, 4.0, 5.0, and 6.0, which adequately cover the range of most bearing applications. The choice for variation of squeeze was made as follows: from Shaw and Macks

$$\text{small bearings: } \frac{R}{c} \leq \frac{1}{.003}$$

$$\text{large bearings: } \frac{R}{c} \geq \frac{1}{.0005}$$

Now let  $\frac{L}{D} = \frac{L}{2R}$  vary from  $\frac{1}{4}$  to 1. Then  $R$  varies from  $2L$  to  $\frac{1}{2}L$  and:

$$\left[ \frac{L}{c} \right]_{\text{MIN}}^2 = \left[ \frac{1}{2(.003)} \right]^2 = .278 \times 10^5$$

$$\left[ \frac{L}{c} \right]_{\text{MAX}}^2 = \left[ \frac{2}{.0005} \right]^2 = 1.6 \times 10^7$$

Now assume a viscosity range from  $10^{-5}$  to  $10^{-6}$  lb-sec/in<sup>2</sup> and a speed range from 100 to 2000 rad/sec. Then:

$$\Lambda^* = \frac{\mu \omega}{P_a} \left( \frac{L}{c} \right)^2$$



$$\lambda_{MIN}^* = \frac{(10^{-6})(100)(.278)(10^5)}{15} = .185$$

$$\lambda_{MAX}^* = \frac{(10^{-5})(2000)(1.6)(10^7)}{15} = 21400$$

However, no bearing applications at the upper limit could be conceived and so it was decided to vary  $\lambda^*$  from .1 to 8000 in 30 steps that would permit easy interpolation. It should be noted that generally the first few entries in each table are uncavitated bearings, which can be recognized by virtue of the fact that  $\phi = 90^\circ$ .

The tabulations are in terms of the entire bearing length (2L) and are converted to dimensional values as follows:

$$F = \bar{F} p_a LR$$

$$K_{mm} = KNM \frac{c}{p_a LR}$$

$$B_{mm} = BNM \frac{\omega c}{p_a LR}$$

For end fed bearings of total length L, divide the above values by 2.



TABLE 4 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 1.5 ECCENTRICITY RATIO = .1

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.319E-01	90.	.000E 00	.000E 00	.319E 00	.169E 00	.000E 00	.638E 00	.000E 00
.2	.638E-01	90.	.000E 00	.000E 00	.638E 00	.338E 00	.000E 00	.128E 01	.000E 00
.4	.128E 00	90.	.000E 00	.000E 00	.128E 01	.676E 00	.000E 00	.255E 01	.000E 00
.6	.191E 00	90.	.000E 00	.000E 00	.191E 01	.101E 01	.000E 00	.383E 01	.000E 00
.8	.255E 00	90.	.000E 00	.000E 00	.255E 01	.135E 01	.000E 00	.510E 01	.000E 00
1.0	.319E 00	90.	.000E 00	.000E 00	.319E 01	.169E 01	.000E 00	.638E 01	.000E 00
1.5	.478E 00	90.	.000E 00	.000E 00	.478E 01	.254E 01	.000E 00	.956E 01	.000E 00
2.0	.636E 00	89.8	.535E-01	.829E-01	.595E 01	.578E 01	.116E 02	.129E 02	.115E 00
4.0	.114E 01	83.7	.431E 00	.772E 00	.862E 01	.827E 01	.168E 02	.195E 02	.111E 01
6.0	.147E 01	77.4	.169E 01	.213E 01	.111E 02	.104E 02	.225E 02	.224E 02	.338E 01
8.0	.172E 01	72.5	.326E 01	.363E 01	.132E 02	.120E 02	.281E 02	.240E 02	.577E 01
10.0	.190E 01	68.6	.486E 01	.507E 01	.148E 02	.132E 02	.334E 02	.254E 02	.806E 01
15.0	.223E 01	61.7	.841E 01	.830E 01	.175E 02	.150E 02	.457E 02	.266E 02	.127E 02
20.0	.245E 01	56.9	.118E 02	.109E 02	.192E 02	.160E 02	.567E 02	.269E 02	.161E 02
25.0	.262E 01	53.3	.146E 02	.131E 02	.203E 02	.167E 02	.669E 02	.271E 02	.190E 02
30.0	.274E 01	50.5	.167E 02	.148E 02	.209E 02	.168E 02	.757E 02	.273E 02	.216E 02
40.0	.295E 01	45.3	.206E 02	.177E 02	.219E 02	.173E 02	.930E 02	.276E 02	.259E 02
50.0	.307E 01	43.2	.232E 02	.197E 02	.220E 02	.171E 02	.107E 03	.280E 02	.294E 02
70.0	.328E 01	33.8	.277E 02	.229E 02	.222E 02	.170E 02	.135E 03	.284E 02	.353E 02
100.0	.348E 01	34.7	.320E 02	.260E 02	.220E 02	.165E 02	.169E 03	.288E 02	.421E 02
150.0	.370E 01	30.3	.369E 02	.294E 02	.213E 02	.157E 02	.219E 03	.292E 02	.509E 02
200.0	.390E 01	27.4	.408E 02	.321E 02	.208E 02	.152E 02	.266E 03	.292E 02	.576E 02
400.0	.419E 01	21.8	.473E 02	.366E 02	.136E 02	.135E 02	.401E 03	.299E 02	.765E 02
700.0	.478E 01	17.5	.568E 02	.435E 02	.175E 02	.126E 02	.600E 03	.288E 02	.939E 02
1000.0	.489E 01	15.4	.593E 02	.452E 02	.160E 02	.115E 02	.739E 03	.283E 02	.107E 03
1500.0	.539E 01	13.0	.669E 02	.508E 02	.151E 02	.108E 02	.992E 03	.274E 02	.122E 03
2000.0	.611E 01	11.3	.749E 02	.532E 02	.151E 02	.108E 02	.126E 04	.257E 02	.131E 03
3000.0	.779E 01	9.4	.997E 02	.753E 02	.163E 02	.118E 02	.181E 04	.237E 02	.146E 03
5000.0	.115E 02	7.8	.160E 03	.113E 03	.203E 02	.149E 02	.293E 04	.233E 02	.173E 03
8000.0	.174E 02	7.0	.228E 03	.171E 03	.277E 02	.205E 02	.463E 04	.265E 02	.220E 03





TABLE 5

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING COEFFICIENTS

PRESSURE RATIO = 1.5      ECCENTRICITY RATIO = .2

	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
1	90.	.000E 00	.000E 00	.334E 00	.209E 00	.000E 00	.668E 00	.000E 00
2	90.	.000E 00	.000E 00	.668E 00	.417E 00	.000E 00	.134E 01	.000E 00
4	90.	.000E 00	.000E 00	.134E 01	.835E 00	.000E 00	.267E 01	.000E 00
6	90.	.000E 00	.000E 00	.200E 01	.125E 01	.000E 00	.401E 01	.000E 00
8	-90.0	.416E-01	.590E-01	.288E 01	.257E 01	.514E 01	.595E 01	.867E-01
1.0	89.4	.149E 00	.230E 00	.319E 01	.287E 01	.570E 01	.717E 01	.316E 00
1.5	85.3	.374E 00	.662E 00	.395E 01	.353E 01	.710E 01	.945E 01	.853E 00
2.0	82.7	.669E 00	.113E 01	.480E 01	.420E 01	.875E 01	.109E 02	.151E 01
4.0	71.8	.258E 01	.310E 01	.812E 01	.645E 01	.162E 02	.143E 02	.450E 01
6.0	64.8	.476E 01	.501E 01	.106E 02	.785E 01	.235E 02	.151E 02	.698E 01
8.0	59.8	.725E 01	.664E 01	.125E 02	.875E 01	.302E 02	.156E 02	.902E 01
10.0	56.1	.933E 01	.803E 01	.139E 02	.933E 01	.364E 02	.160E 02	.108E 02
15.0	49.7	.137E 02	.107E 02	.160E 02	.101E 02	.505E 02	.167E 02	.144E 02
20.0	45.4	.172E 02	.128E 02	.173E 02	.105E 02	.629E 02	.171E 02	.173E 02
25.0	42.4	.199E 02	.143E 02	.180E 02	.107E 02	.740E 02	.175E 02	.197E 02
30.0	40.0	.222E 02	.156E 02	.184E 02	.107E 02	.844E 02	.178E 02	.218E 02
40.0	36.4	.261E 02	.176E 02	.189E 02	.108E 02	.104E 03	.181E 02	.253E 02
50.0	33.9	.288E 02	.191E 02	.191E 02	.107E 02	.120E 03	.185E 02	.283E 02
70.0	30.3	.329E 02	.212E 02	.189E 02	.104E 02	.150E 03	.188E 02	.332E 02
100.0	26.8	.373E 02	.234E 02	.185E 02	.998E 01	.189E 03	.191E 02	.389E 02
150.0	23.3	.435E 02	.267E 02	.184E 02	.982E 01	.250E 03	.192E 02	.460E 02
200.0	21.3	.445E 02	.270E 02	.171E 02	.904E 01	.290E 03	.198E 02	.521E 02
400.0	16.3	.551E 02	.327E 02	.159E 02	.834E 01	.470E 03	.194E 02	.677E 02
700.0	13.2	.617E 02	.362E 02	.143E 02	.744E 01	.676E 03	.189E 02	.825E 02
1000.0	11.2	.725E 02	.422E 02	.142E 02	.745E 01	.901E 03	.178E 02	.914E 02
1500.0	9.4	.936E 02	.542E 02	.153E 02	.314E 01	.129E 04	.165E 02	.102E 03
2000.0	8.4	.116E 03	.671E 02	.170E 02	.918E 01	.169E 04	.162E 02	.112E 03
3000.0	7.4	.164E 03	.943E 02	.212E 02	.117E 02	.249E 04	.170E 02	.133E 03
5000.0	6.7	.262E 03	.150E 03	.308E 02	.172E 02	.410E 04	.210E 02	.179E 03
8000.0	6.4	.411E 03	.236E 03	.460E 02	.260E 02	.653E 04	.285E 02	.256E 03



TABLE 6 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 1.5      ECCENTRICITY RATIO = .3

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.109E 00	90.	.000E 00	.000E 00	.362E 00	.288E 00	.000E 00	.723E 00	.000E 00
.2	.217E 00	90.	.000E 00	.000E 00	.723E 00	.576E 00	.000E 00	.145E 01	.000E 00
.4	.434E 00	+89.9	.674E-02	.148E-01	.186E 01	.144E 01	.287E 01	.374E 01	.157E-01
.6	.642E 00	88.9	.192E 00	.347E 00	.228E 01	.182E 01	.360E 01	.518E 01	.424E 00
.8	.832E 00	86.7	.380E 00	.703E 00	.267E 01	.212E 01	.425E 01	.631E 01	.859E 00
1.0	.101E 01	84.3	.565E 00	.104E 01	.310E 01	.241E 01	.499E 01	.724E 01	.129E 01
1.5	.139E 01	79.0	.110E 01	.184E 01	.428E 01	.312E 01	.717E 01	.901E 01	.233E 01
2.0	.173E 01	74.7	.176E 01	.258E 01	.551E 01	.378E 01	.961E 01	.102E 02	.334E 01
4.0	.274E 01	63.2	.524E 01	.527E 01	.991E 01	.575E 01	.198E 02	.121E 02	.664E 01
6.0	.346E 01	56.5	.894E 01	.744E 01	.131E 02	.695E 01	.295E 02	.131E 02	.927E 01
8.0	.401E 01	51.9	.124E 02	.921E 01	.154E 02	.771E 01	.384E 02	.138E 02	.115E 02
10.0	.446E 01	48.6	.155E 02	.107E 02	.172E 02	.827E 01	.468E 02	.143E 02	.133E 02
15.0	.525E 01	42.8	.218E 02	.136E 02	.198E 02	.894E 01	.653E 02	.152E 02	.172E 02
20.0	.578E 01	39.0	.265E 02	.156E 02	.212E 02	.919E 01	.813E 02	.157E 02	.203E 02
25.0	.621E 01	36.3	.304E 02	.172E 02	.221E 02	.933E 01	.960E 02	.161E 02	.228E 02
30.0	.663E 01	34.2	.341E 02	.187E 02	.229E 02	.952E 01	.111E 03	.164E 02	.251E 02
40.0	.706E 01	31.2	.387E 02	.204E 02	.231E 02	.938E 01	.134E 03	.169E 02	.290E 02
50.0	.749E 01	28.9	.428E 02	.220E 02	.234E 02	.934E 01	.156E 03	.172E 02	.322E 02
70.0	.806E 01	25.8	.487E 02	.243E 02	.233E 02	.911E 01	.196E 03	.176E 02	.375E 02
100.0	.916E 01	22.7	.591E 02	.281E 02	.241E 02	.937E 01	.257E 03	.177E 02	.436E 02
150.0	.920E 01	20.1	.604E 02	.287E 02	.219E 02	.833E 01	.316E 03	.186E 02	.522E 02
200.0	.973E 01	18.0	.655E 02	.307E 02	.212E 02	.805E 01	.384E 03	.187E 02	.587E 02
400.0	.112E 02	13.9	.790E 02	.350E 02	.194E 02	.738E 01	.612E 03	.185E 02	.762E 02
700.0	.136E 02	10.9	.936E 02	.443E 02	.189E 02	.728E 01	.943E 03	.173E 02	.910E 02
1000.0	.168E 02	9.4	.123E 03	.548E 02	.202E 02	.793E 01	.129E 04	.164E 02	.101E 03
1500.0	.226E 02	8.1	.167E 03	.741E 02	.236E 02	.956E 01	.188E 04	.162E 02	.116E 03
2000.0	.286E 02	7.4	.213E 03	.943E 02	.277E 02	.115E 02	.248E 04	.170E 02	.132E 03
3000.0	.411E 02	6.8	.308E 03	.136E 03	.369E 02	.156E 02	.368E 04	.198E 02	.166E 03
5000.0	.665E 02	6.4	.500E 03	.220E 03	.563E 02	.243E 02	.609E 04	.272E 02	.242E 03
8000.0	.105E 03	6.3	.791E 03	.348E 03	.866E 02	.377E 02	.971E 04	.394E 02	.361E 03



TABLE 7 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 1.5 ECCENTRICITY RATIO = .4

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.163E 00	90.	.000E 00	.000E 00	.408E 00	.437E 00	.000E 00	.816E 00	.000E 00
.2	.326E 00	90.	.000E 00	.000E 00	.816E 00	.874E 00	.000E 00	.163E 01	.000E 00
.4	.637E 00	87.8	.248E 00	.554E 00	.196E 01	.132E 01	.261E 01	.441E 01	.582E 00
.6	.911E 00	83.7	.571E 00	.118E 01	.255E 01	.165E 01	.351E 01	.573E 01	.132E 01
.8	.116E 01	80.1	.909E 00	.173E 01	.323E 01	.195E 01	.459E 01	.687E 01	.202E 01
1.0	.140E 01	77.0	.129E 01	.227E 01	.394E 01	.222E 01	.578E 01	.765E 01	.267E 01
1.5	.194E 01	71.1	.240E 01	.348E 01	.580E 01	.287E 01	.910E 01	.897E 01	.406E 01
2.0	.243E 01	66.8	.370E 01	.454E 01	.764E 01	.348E 01	.127E 02	1.000E 01	.528E 01
4.0	.404E 01	56.2	.931E 01	.798E 01	.140E 02	.542E 01	.273E 02	.125E 02	.935E 01
6.0	.524E 01	50.2	.160E 02	.107E 02	.187E 02	.668E 01	.411E 02	.139E 02	.126E 02
8.0	.620E 01	46.1	.218E 02	.129E 02	.222E 02	.757E 01	.541E 02	.148E 02	.153E 02
10.0	.693E 01	43.0	.259E 02	.147E 02	.247E 02	.811E 01	.659E 02	.155E 02	.176E 02
15.0	.837E 01	38.0	.375E 02	.193E 02	.289E 02	.901E 01	.929E 02	.166E 02	.224E 02
20.0	.937E 01	34.6	.456E 02	.209E 02	.312E 02	.940E 01	.117E 03	.173E 02	.262E 02
25.0	.103E 02	32.2	.530E 02	.232E 02	.330E 02	.980E 01	.139E 03	.178E 02	.294E 02
30.0	.109E 02	30.4	.581E 02	.247E 02	.338E 02	.988E 01	.159E 03	.183E 02	.323E 02
40.0	.118E 02	27.6	.655E 02	.271E 02	.346E 02	.986E 01	.194E 03	.189E 02	.372E 02
50.0	.125E 02	25.6	.732E 02	.291E 02	.349E 02	.982E 01	.226E 03	.193E 02	.414E 02
70.0	.140E 02	22.8	.852E 02	.330E 02	.360E 02	.101E 02	.291E 03	.197E 02	.480E 02
100.0	.150E 02	20.4	.954E 02	.356E 02	.353E 02	.979E 01	.362E 03	.206E 02	.565E 02
150.0	.158E 02	17.8	.104F 03	.380E 02	.333E 02	.911E 01	.465E 03	.213E 02	.675E 02
200.0	.174E 02	15.9	.118E 03	.421E 02	.334E 02	.914E 01	.578E 03	.212E 02	.754E 02
400.0	.200E 02	12.3	.140E 03	.439E 02	.304E 02	.836E 01	.915E 03	.212E 02	.984E 02
700.0	.260E 02	9.7	.186E 03	.639E 02	.317E 02	.902E 01	.145E 04	.198E 02	.117E 03
1000.0	.330E 02	8.4	.240E 03	.816F 02	.355E 02	.105E 02	.201E 04	.194E 02	.132E 03
1500.0	.457E 02	7.5	.334E 03	.113E 03	.438E 02	.134E 02	.295E 04	.205E 02	.158E 03
2000.0	.587E 02	7.0	.431E 03	.145E 03	.530F 02	.167E 02	.390E 04	.226E 02	.185E 03
3000.0	.853E 02	6.6	.629E 03	.212E 03	.727E 02	.235E 02	.581E 04	.280E 02	.243E 03
5000.0	.139E 03	6.3	.103E 04	.346E 03	.114E 03	.375E 02	.963E 04	.405E 02	.367E 03
8000.0	.221E 03	6.2	.163E 04	.548E 03	.177E 03	.589E 02	.154E 05	.606E 02	.559E 03





TABLE 8 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 1.5		ECCENTRICITY RATIO = .5							
	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.242E 00	90.	.000E 00	.000E 00	.483E 00	.725E 00	.000E 00	.967E 00	.000E 00
.2	.476E 00	83.4	.146E 00	.444E 00	.156E 01	.841E 00	.165E 01	.338E 01	.367E 00
.4	.886E 00	81.0	.691E 00	.156E 01	.255E 01	.121E 01	.294E 01	.531E 01	.161E 01
.6	.126E 01	75.4	.136E 01	.257E 01	.370E 01	.144E 01	.459E 01	.637E 01	.272E 01
.8	.161E 01	71.2	.213E 01	.343E 01	.492E 01	.163E 01	.645E 01	.728E 01	.370E 01
1.0	.195E 01	68.1	.297E 01	.421E 01	.615E 01	.183E 01	.842E 01	.810E 01	.458E 01
1.5	.277E 01	62.5	.530E 01	.590E 01	.918E 01	.235E 01	.137E 02	.984E 01	.651E 01
2.0	.355E 01	58.7	.738E 01	.737E 01	.121E 02	.290E 01	.191E 02	.112E 02	.821E 01
4.0	.622E 01	49.8	.193E 02	.121E 02	.223E 02	.494E 01	.414E 02	.148E 02	.138E 02
6.0	.834E 01	44.7	.309E 02	.159E 02	.300E 02	.650E 01	.629E 02	.168E 02	.183E 02
8.0	.101E 02	41.2	.415E 02	.190E 02	.359E 02	.765E 01	.832E 02	.182E 02	.220E 02
10.0	.115E 02	38.6	.512E 02	.217E 02	.405E 02	.847E 01	.102E 03	.192E 02	.253E 02
15.0	.142E 02	34.1	.715E 02	.268E 02	.481E 02	.980E 01	.145E 03	.209E 02	.321E 02
20.0	.163E 02	31.2	.830E 02	.308E 02	.529E 02	.106E 02	.184E 03	.220E 02	.375E 02
25.0	.181E 02	29.1	.103E 03	.344E 02	.570E 02	.114E 02	.222E 03	.229E 02	.423E 02
30.0	.190E 02	27.5	.112E 03	.363E 02	.578E 02	.113E 02	.251E 03	.235E 02	.464E 02
40.0	.212E 02	25.0	.131E 03	.406E 02	.606E 02	.117E 02	.312E 03	.244E 02	.535E 02
50.0	.226E 02	23.2	.144E 03	.436E 02	.617E 02	.118E 02	.365E 03	.250E 02	.595E 02
70.0	.264E 02	20.7	.176E 03	.510E 02	.662E 02	.129E 02	.479E 03	.257E 02	.694E 02
100.0	.272E 02	18.6	.187E 03	.528E 02	.628E 02	.120E 02	.581E 03	.274E 02	.824E 02
150.0	.299E 02	16.1	.212E 03	.584E 02	.613E 02	.116E 02	.767E 03	.231E 02	.983E 02
200.0	.336E 02	14.5	.244E 03	.660E 02	.629E 02	.121E 02	.963E 03	.281E 02	.110E 03
400.0	.389E 02	11.2	.293E 03	.748E 02	.578E 02	.112E 02	.153E 04	.283E 02	.145E 03
700.0	.527E 02	8.9	.405E 03	.104E 03	.635E 02	.131E 02	.247E 04	.272E 02	.174E 03
1000.0	.684E 02	7.9	.531E 03	.136E 03	.736E 02	.160E 02	.343E 04	.277E 02	.201E 03
1500.0	.960E 02	7.1	.750E 03	.191E 03	.938E 02	.215E 02	.506E 04	.308E 02	.247E 03
2000.0	.124E 03	6.8	.974E 03	.247E 03	.116E 03	.273E 02	.669E 04	.351E 02	.296E 03
3000.0	.182E 03	6.5	.143E 04	.361E 03	.162E 03	.392E 02	.998E 04	.452E 02	.400E 03
5000.0	.298E 03	6.3	.234E 04	.592E 03	.257E 03	.635E 02	.166E 05	.576E 02	.618E 03
8000.0	.473E 03	6.2	.373E 04	.940E 03	.402E 03	.100E 03	.265E 05	.103E 03	.953E 03





TABLE 9 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 1.5 ECCENTRICITY RATIO = .6

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.363E 00	88.5	.999E-01	.433E 00	.137E 01	.550E 00	.108E 01	.288E 01	.275E 00
.2	.683E 00	80.5	.587E 00	.160E 01	.228E 01	.730E 00	.205E 01	.438E 01	.138E 01
.4	.127E 01	69.9	.203E 01	.345E 01	.451E 01	.710E 00	.485E 01	.596E 01	.337E 01
.6	.184E 01	64.1	.379E 01	.488E 01	.680E 01	.659E 00	.809E 01	.727E 01	.503E 01
.8	.240E 01	60.3	.570E 01	.611E 01	.905E 01	.660E 00	.115E 02	.844E 01	.648E 01
1.0	.295E 01	57.6	.771E 01	.724E 01	.113E 02	.709E 00	.150E 02	.953E 01	.781E 01
1.5	.430E 01	53.2	.120E 02	.980E 01	.166E 02	.988E 00	.240E 02	.119E 02	.108E 02
2.0	.560E 01	50.3	.126E 02	.121E 02	.217E 02	.141E 01	.332E 02	.140E 02	.134E 02
4.0	.103E 02	43.5	.424E 02	.197E 02	.398E 02	.353E 01	.710E 02	.196E 02	.223E 02
6.0	.143E 02	39.5	.665E 02	.257E 02	.545E 02	.553E 01	.108E 03	.230E 02	.294E 02
8.0	.177E 02	36.7	.892E 02	.308E 02	.662E 02	.715E 01	.144E 03	.254E 02	.355E 02
10.0	.206E 02	34.6	.111E 03	.353E 02	.758E 02	.850E 01	.178E 03	.272E 02	.408E 02
15.0	.264E 02	30.8	.157E 03	.442E 02	.930E 02	.108E 02	.256E 03	.302E 02	.520E 02
20.0	.310E 02	28.3	.196E 03	.514E 02	.105E 03	.125E 02	.329E 03	.321E 02	.611E 02
25.0	.345E 02	26.5	.227E 03	.571E 02	.113E 03	.135E 02	.394E 03	.338E 02	.691E 02
30.0	.370E 02	25.0	.252E 03	.611E 02	.117E 03	.139E 02	.452E 03	.348E 02	.760E 02
40.0	.417E 02	22.8	.297E 03	.638E 02	.125E 03	.149E 02	.565E 03	.364E 02	.879E 02
50.0	.456E 02	21.2	.335E 03	.751E 02	.130E 03	.156E 02	.670E 03	.375E 02	.981E 02
70.0	.537E 02	19.1	.411E 03	.883E 02	.142E 03	.178E 02	.879E 03	.396E 02	.116E 03
100.0	.556E 02	17.1	.439E 03	.917E 02	.135E 03	.163E 02	.107E 04	.422E 02	.138E 03
150.0	.631E 02	14.8	.515E 03	.104E 03	.136E 03	.165E 02	.144E 04	.434E 02	.165E 03
200.0	.702E 02	13.4	.595E 03	.116E 03	.139E 03	.173E 02	.179E 04	.442E 02	.187E 03
400.0	.848E 02	10.4	.731E 03	.140E 03	.133E 03	.171E 02	.292E 04	.447E 02	.246E 03
700.0	.118E 03	8.4	.104E 04	.196E 03	.153E 03	.218E 02	.475E 04	.445E 02	.303E 03
1000.0	.155E 03	7.5	.138E 04	.257E 03	.183E 03	.280E 02	.663E 04	.470E 02	.356E 03
1500.0	.220E 03	6.9	.197E 04	.355E 03	.239E 03	.391E 02	.980E 04	.545E 02	.450E 03
2000.0	.286E 03	6.6	.257E 04	.474E 03	.298E 03	.507E 02	.130E 05	.638E 02	.549E 03
3000.0	.420E 03	6.4	.377E 04	.696E 03	.422E 03	.742E 02	.194E 05	.845E 02	.757E 03
5000.0	.690E 03	6.2	.621E 04	.114E 04	.677E 03	.122E 03	.322E 05	.129E 03	.119E 04
8000.0	.110E 04	6.1	.938E 04	.182E 04	.106E 04	.193E 03	.514E 05	.199E 03	.185E 04



TABLE 10 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 1.5 ECCENTRICITY RATIO = .7

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.560E 00	77.2	.714E 00	.204E 01	.247E 01	.287E 00	.171E 01	.397E 01	.150E 01
.2	.107E 01	65.1	.255E 01	.397E 01	.511E 01	-.261E 00	.461E 01	.530E 01	.356E 01
.4	.210E 01	55.0	.755E 01	.650E 01	.102E 02	-.113E 01	.114E 02	.725E 01	.676E 01
.6	.312E 01	50.5	.128E 02	.877E 01	.150E 02	-.168E 01	.184E 02	.900E 01	.943E 01
.8	.413E 01	47.8	.193E 02	.108E 02	.196E 02	-.207E 01	.256E 02	.107E 02	.119E 02
1.0	.514E 01	46.0	.238E 02	.127E 02	.241E 02	-.235E 01	.328E 02	.123E 02	.141E 02
1.5	.765E 01	43.2	.379E 02	.172E 02	.350E 02	-.276E 01	.510E 02	.160E 02	.194E 02
2.0	.101E 02	41.4	.523E 02	.214E 02	.455E 02	-.287E 01	.695E 02	.194E 02	.243E 02
4.0	.195E 02	37.0	.112E 03	.358E 02	.842E 02	-.182E 01	.145E 03	.296E 02	.412E 02
6.0	.278E 02	34.3	.173E 03	.475E 02	.117E 03	.201E 00	.220E 03	.364E 02	.552E 02
8.0	.352E 02	32.2	.232E 03	.576E 02	.146E 03	.232E 01	.294E 03	.413E 02	.673E 02
10.0	.420E 02	30.6	.289E 03	.666E 02	.170E 03	.438E 01	.365E 03	.451E 02	.780E 02
15.0	.558E 02	27.6	.417E 03	.852E 02	.217E 03	.851E 01	.535E 03	.516E 02	.100E 03
20.0	.673E 02	25.5	.531E 03	.101E 03	.253E 03	.119E 02	.694E 03	.561E 02	.119E 03
25.0	.760E 02	23.9	.622E 03	.112E 03	.276E 03	.138E 02	.838E 03	.596E 02	.136E 03
30.0	.831E 02	22.6	.702E 03	.122E 03	.293E 03	.151E 02	.972E 03	.618E 02	.150E 03
40.0	.958E 02	20.8	.845E 03	.139E 03	.320E 03	.177E 02	.123E 04	.655E 02	.174E 03
50.0	.107E 03	19.4	.972E 03	.155E 03	.342E 03	.201E 02	.147E 04	.582E 02	.195E 03
70.0	.127E 03	17.6	.120F 04	.182E 03	.380E 03	.248E 02	.193E 04	.738E 02	.234E 03
100.0	.135E 03	15.7	.131E 04	.193E 03	.371E 03	.228E 02	.241E 04	.786E 02	.280E 03
150.0	.158E 03	13.7	.159E 04	.225E 03	.387E 03	.250E 02	.329E 04	.817E 02	.337E 03
200.0	.176E 03	12.4	.181E 04	.251E 03	.399E 03	.271E 02	.407E 04	.844E 02	.384E 03
400.0	.220E 03	9.7	.235E 04	.314E 03	.400E 03	.294E 02	.676E 04	.869E 02	.512E 03
700.0	.314E 03	8.0	.343E 04	.447E 03	.480E 03	.426E 02	.111E 05	.902E 02	.646E 03
1000.0	.417E 03	7.3	.460E 04	.593E 03	.586E 03	.582E 02	.155E 05	.989E 02	.777E 03
1500.0	.595E 03	6.8	.659E 04	.845E 03	.781E 03	.855E 02	.230E 05	.119E 03	.101E 04
2000.0	.776E 03	6.5	.853E 04	.110E 04	.986E 03	.113E 03	.304E 05	.143E 03	.125E 04
3000.0	.114E 04	6.3	.127E 05	.162E 04	.141E 04	.169E 03	.454E 05	.194E 03	.175E 04
5000.0	.188E 04	6.2	.210E 05	.267E 04	.227E 04	.281E 03	.755E 05	.301E 03	.278E 04
8000.0	.299E 04	6.1	.334E 05	.425E 04	.359E 04	.449E 03	.121E 06	.466E 03	.435E 04



TABLE 11 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0 ECCENTRICITY RATIO = .1

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.319E-01	90.	.000E 00	.000E 00	.319E 00	.169E 00	.000E 00	.538E 00	.000E 00
.2	.638E-01	90.	.000E 00	.000E 00	.638E 00	.338E 00	.000E 00	.128E 01	.000E 00
.4	.128E 00	90.	.000E 00	.000E 00	.128E 01	.676E 00	.000E 00	.255E 01	.000E 00
.6	.191E 00	90.	.000E 00	.000E 00	.191E 01	.101E 01	.000E 00	.383E 01	.000E 00
.8	.255E 00	90.	.000E 00	.000E 00	.255E 01	.135E 01	.000E 00	.510E 01	.000E 00
1.0	.319E 00	90.	.000E 00	.000E 00	.319E 01	.169E 01	.000E 00	.638E 01	.000E 00
1.5	.478E 00	90.	.000E 00	.000E 00	.478E 01	.254E 01	.000E 00	.956E 01	.000E 00
2.0	.638E 00	90.	.000E 00	.000E 00	.638E 01	.338E 01	.000E 00	.128E 02	.000E 00
4.0	.127E 01	89.8	.111E 00	.166E 00	.119E 02	.116E 02	.231E 02	.258E 02	.229E 00
6.0	.183E 01	87.2	.262E 00	.670E 00	.145E 02	.140E 02	.281E 02	.340E 02	.762E 00
8.0	.228E 01	83.7	.861E 00	.154E 01	.172E 02	.165E 02	.335E 02	.391E 02	.221E 01
10.0	.264E 01	80.3	.200E 01	.234E 01	.198E 02	.188E 02	.392E 02	.422E 02	.439E 01
15.0	.332E 01	73.6	.571E 01	.652E 01	.254E 02	.233E 02	.533E 02	.473E 02	.103E 02
20.0	.380E 01	68.6	.971E 01	.101E 02	.296E 02	.264E 02	.669E 02	.509E 02	.161E 02
25.0	.417E 01	64.8	.136E 02	.135E 02	.327E 02	.286E 02	.796E 02	.530E 02	.213E 02
30.0	.445E 01	61.7	.172E 02	.166E 02	.351E 02	.301E 02	.915E 02	.532E 02	.253E 02
40.0	.490E 01	56.9	.236E 02	.219E 02	.384E 02	.321E 02	.113E 03	.538E 02	.322E 02
50.0	.525E 01	53.3	.291E 02	.262E 02	.407E 02	.333E 02	.134E 03	.542E 02	.380E 02
70.0	.568E 01	48.2	.374E 02	.325E 02	.427E 02	.340E 02	.168E 03	.550E 02	.476E 02
100.0	.614E 01	43.2	.465E 02	.393E 02	.440E 02	.342E 02	.214E 03	.560E 02	.589E 02
150.0	.668E 01	37.9	.575E 02	.473E 02	.447E 02	.340E 02	.283E 03	.568E 02	.732E 02
200.0	.697E 01	34.7	.641E 02	.520E 02	.440E 02	.330E 02	.338E 03	.577E 02	.843E 02
400.0	.780E 01	27.4	.215E 02	.643E 02	.416E 02	.305E 02	.531E 03	.584E 02	.115E 03
700.0	.833E 01	22.8	.979E 02	.722E 02	.384E 02	.273E 02	.743E 03	.595E 02	.145E 03
1000.0	.864E 01	20.1	.996E 02	.769E 02	.357E 02	.258E 02	.928E 03	.597E 02	.167E 03
1500.0	.963E 01	17.0	.115E 03	.830E 02	.345E 02	.248E 02	.125E 04	.576E 02	.193E 03
2000.0	.977E 01	15.4	.119E 03	.904E 02	.320E 02	.229E 02	.148E 04	.576E 02	.214E 03
3000.0	.108E 02	13.0	.134E 03	.102E 03	.301E 02	.216E 02	.198E 04	.547E 02	.243E 03
5000.0	.138E 02	10.2	.176E 03	.133E 03	.311E 02	.224E 02	.307E 04	.489E 02	.278E 03
8000.0	.192E 02	3.4	.249E 03	.187E 03	.363E 02	.264E 02	.474E 04	.461E 02	.319E 03





TABLE 12 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0 ECCENTRICITY RATIO = .2

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYX	BXY
1	.668E-01	90.	.000E 00	.000E 00	.334E 00	.209E 00	.000E 00	.668E 00	.000E 00
2	.134E 00	90.	.000E 00	.000E 00	.668E 00	.417E 00	.000E 00	.134E 01	.000E 00
4	.267E 00	90.	.000E 00	.000E 00	.134E 01	.835E 00	.000E 00	.267E 01	.000E 00
6	.401E 00	90.	.000E 00	.000E 00	.200E 01	.125E 01	.000E 00	.401E 01	.000E 00
8	.534E 00	90.	.000E 00	.000E 00	.267E 01	.167E 01	.000E 00	.534E 01	.000E 00
1.0	.668E 00	90.	.000E 00	.000E 00	.334E 01	.209E 01	.000E 00	.668E 01	.000E 00
1.5	.100E 01	-89.9	.238E-01	.418E-01	.556E 01	.495E 01	.990E 01	.112E 02	.604E-01
2.0	.132E 01	89.4	.298E 00	.459E 00	.637E 01	.573E 01	.114E 02	.143E 02	.632E 00
4.0	.238E 01	82.7	.134E 01	.227E 01	.960E 01	.840E 01	.175E 02	.219E 02	.303E 01
6.0	.316E 01	76.5	.305E 01	.425E 01	.131E 02	.109E 02	.248E 02	.257E 02	.598E 01
8.0	.378E 01	71.8	.516E 01	.619E 01	.162E 02	.129E 02	.324E 02	.285E 02	.901E 01
10.0	.428E 01	68.0	.752E 01	.817E 01	.190E 02	.145E 02	.398E 02	.295E 02	.116E 02
15.0	.522E 01	60.9	.134E 02	.125E 02	.242E 02	.171E 02	.572E 02	.310E 02	.171E 02
20.0	.590E 01	56.1	.187E 02	.161E 02	.277E 02	.187E 02	.729E 02	.320E 02	.216E 02
25.0	.644E 01	52.5	.234E 02	.190E 02	.303E 02	.197E 02	.876E 02	.328E 02	.254E 02
30.0	.685E 01	49.7	.274E 02	.215E 02	.321E 02	.203E 02	.101E 03	.334E 02	.288E 02
40.0	.753E 01	45.4	.344E 02	.255E 02	.345E 02	.211E 02	.126E 03	.343E 02	.345E 02
50.0	.801E 01	42.4	.398E 02	.286E 02	.359E 02	.214E 02	.148E 03	.350E 02	.393E 02
70.0	.872E 01	38.0	.483E 02	.332E 02	.373E 02	.214E 02	.188E 03	.360E 02	.473E 02
100.0	.951E 01	33.9	.576E 02	.382E 02	.382E 02	.214E 02	.240E 03	.369E 02	.566E 02
150.0	.103E 02	29.6	.674E 02	.432E 02	.377E 02	.206E 02	.314E 03	.378E 02	.686E 02
200.0	.108E 02	26.8	.745E 02	.468E 02	.371E 02	.200E 02	.379E 03	.382E 02	.778E 02
400.0	.120E 02	21.3	.890E 02	.541E 02	.343E 02	.181E 02	.579E 03	.397E 02	.104E 03
700.0	.136E 02	17.2	.106E 03	.633E 02	.324E 02	.169E 02	.860E 03	.389E 02	.129E 03
1000.0	.141E 02	15.1	.113E 03	.667E 02	.301E 02	.157E 02	.107E 04	.389E 02	.147E 03
1500.0	.155E 02	12.8	.127E 03	.742E 02	.284E 02	.148E 02	.142E 04	.375E 02	.169E 03
2000.0	.175E 02	11.2	.145E 03	.844E 02	.284E 02	.149E 02	.180E 04	.355E 02	.183E 03
3000.0	.222E 02	9.4	.197E 03	.108E 03	.306E 02	.163E 02	.258E 04	.330E 02	.204E 03
5000.0	.328E 02	7.8	.230E 03	.161E 03	.381E 02	.208E 02	.418E 04	.329E 02	.244E 03
8000.0	.494E 02	7.0	.425E 03	.244E 03	.518E 02	.288E 02	.659E 04	.376E 02	.311E 03





TABLE 13 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0 ECCENTRICITY RATIO = .3

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
1	.109E 00	90.	.000E 00	.000E 00	.362E 00	.288E 00	.000E 00	.723E 00	.000E 00
2	.217E 00	90.	.000E 00	.000E 00	.723E 00	.576E 00	.000E 00	.145E 01	.000E 00
4	.434E 00	90.	.000E 00	.000E 00	.145E 01	.115E 01	.000E 00	.289E 01	.000E 00
6	.651E 00	90.	.000E 00	.000E 00	.217E 01	.173E 01	.000E 00	.434E 01	.000E 00
8	.868E 00	-89.9	.139E-01	.297E-01	.372E 01	.288E 01	.575E 01	.747E 01	.314E-01
10	.108E 01	89.7	.170E 00	.344E 00	.419E 01	.331E 01	.657E 01	.900E 01	.417E 00
15	.157E 01	87.3	.666E 00	.123E 01	.515E 01	.410E 01	.817E 01	.121E 02	.150E 01
20	.201E 01	84.3	.113E 01	.208E 01	.620E 01	.482E 01	.998E 01	.145E 02	.257E 01
40	.345E 01	74.7	.351E 01	.516E 01	.110E 02	.757E 01	.192E 02	.204E 02	.668E 01
60	.458E 01	68.1	.631E 01	.801E 01	.157E 02	.980E 01	.295E 02	.227E 02	.102E 02
80	.549E 01	63.2	.105E 02	.105E 02	.198E 02	.115E 02	.396E 02	.242E 02	.133E 02
100	.627E 01	59.5	.142E 02	.128E 02	.233E 02	.129E 02	.495E 02	.254E 02	.160E 02
150	.776E 01	52.9	.231E 02	.176E 02	.298E 02	.151E 02	.724E 02	.273E 02	.219E 02
200	.893E 01	48.6	.310E 02	.215E 02	.344E 02	.165E 02	.937E 02	.287E 02	.267E 02
250	.977E 01	45.3	.376E 02	.245E 02	.374E 02	.173E 02	.113E 03	.296E 02	.308E 02
300	.105E 02	42.8	.436E 02	.271E 02	.397E 02	.179E 02	.131E 03	.303E 02	.343E 02
400	.116E 02	39.0	.530E 02	.311E 02	.424E 02	.184E 02	.163E 03	.315E 02	.405E 02
500	.124E 02	36.3	.609E 02	.343E 02	.441E 02	.187E 02	.192E 03	.323E 02	.457E 02
700	.138E 02	32.5	.737E 02	.395E 02	.464E 02	.191E 02	.246E 03	.334E 02	.543E 02
1000	.150E 02	28.9	.857E 02	.441E 02	.468E 02	.187E 02	.313E 03	.344E 02	.645E 02
1500	.165E 02	25.1	.100E 03	.498E 02	.467E 02	.182E 02	.413E 03	.352E 02	.774E 02
2000	.183E 02	22.7	.116E 03	.562E 02	.481E 02	.187E 02	.515E 03	.354E 02	.872E 02
4000	.195E 02	18.0	.131E 03	.613E 02	.423E 02	.161E 02	.768E 03	.374E 02	.117E 03
7000	.220E 02	14.6	.154E 03	.704E 02	.398E 02	.151E 02	.112E 04	.372E 02	.145E 03
10000	.237E 02	12.7	.169E 03	.766E 02	.378E 02	.144E 02	.144E 04	.364E 02	.164E 03
15000	.282E 02	10.6	.205E 03	.919E 02	.381E 02	.147E 02	.200E 04	.342E 02	.186E 03
20000	.335E 02	9.4	.246E 03	.110E 03	.404E 02	.159E 02	.258E 04	.328E 02	.202E 03
30000	.451E 02	8.1	.334E 03	.148E 03	.472E 02	.191E 02	.376E 04	.325E 02	.232E 03
50000	.697E 02	7.1	.521E 03	.230E 03	.644E 02	.270E 02	.615E 04	.366E 02	.298E 03
80000	.108E 03	6.6	.307E 03	.355E 03	.930E 02	.398E 02	.977E 04	.467E 02	.407E 03



TABLE 14 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0                      ECCENTRICITY RATIO = .4

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.163E 00	90.	.000E 00	.000E 00	.408E 00	.437E 00	.000E 00	.816E 00	.000E 00
.2	.326E 00	90.	.000E 00	.000E 00	.816E 00	.874E 00	.000E 00	.153E 01	.000E 00
.4	.653E 00	90.	.000E 00	.000E 00	.163E 01	.175E 01	.000E 00	.326E 01	.000E 00
.6	.973E 00	89.5	.135E 00	.439E 00	.338E 01	.224E 01	.441E 01	.722E 01	.433E 00
.8	.127E 01	87.8	.496E 00	.111E 01	.391E 01	.264E 01	.522E 01	.882E 01	.116E 01
1.0	.155E 01	85.7	.818E 00	.176E 01	.447E 01	.298E 01	.607E 01	.102E 02	.192E 01
1.5	.220E 01	80.9	.164E 01	.319E 01	.611E 01	.375E 01	.861E 01	.132E 02	.370E 01
2.0	.279E 01	77.0	.258E 01	.453E 01	.788E 01	.444E 01	.116E 02	.153E 02	.534E 01
4.0	.486E 01	66.8	.739E 01	.907E 01	.153E 02	.695E 01	.253E 02	.200E 02	.106E 02
6.0	.659E 01	60.6	.133E 02	.128E 02	.221E 02	.908E 01	.400E 02	.230E 02	.149E 02
8.0	.808E 01	56.2	.196E 02	.160E 02	.281E 02	.108E 02	.545E 02	.251E 02	.187E 02
10.0	.935E 01	52.8	.259E 02	.188E 02	.331E 02	.122E 02	.686E 02	.266E 02	.221E 02
15.0	.119E 02	47.0	.408E 02	.247E 02	.428E 02	.147E 02	.102E 03	.292E 02	.293E 02
20.0	.139E 02	43.0	.537E 02	.294E 02	.494E 02	.162E 02	.132E 03	.310E 02	.352E 02
25.0	.155E 02	40.2	.652E 02	.333E 02	.544E 02	.173E 02	.160E 03	.322E 02	.402E 02
30.0	.167E 02	38.0	.749E 02	.365E 02	.578E 02	.180E 02	.186E 03	.333E 02	.447E 02
40.0	.187E 02	34.6	.913E 02	.417E 02	.624E 02	.189E 02	.233E 03	.347E 02	.524E 02
50.0	.206E 02	32.2	.106E 03	.463E 02	.661E 02	.196E 02	.279E 03	.357E 02	.589E 02
70.0	.225E 02	28.9	.124E 03	.517E 02	.681E 02	.196E 02	.352E 03	.373E 02	.698E 02
100.0	.250E 02	25.6	.146E 03	.591E 02	.698E 02	.196E 02	.452E 03	.386E 02	.827E 02
150.0	.289E 02	22.2	.130E 03	.683E 02	.731E 02	.204E 02	.615E 03	.395E 02	.989E 02
200.0	.299E 02	20.4	.191E 03	.712E 02	.706E 02	.196E 02	.723E 03	.412E 02	.113E 03
400.0	.348E 02	15.9	.235E 03	.842E 02	.667E 02	.183E 02	.116E 04	.423E 02	.151E 03
700.0	.385E 02	13.0	.268E 03	.939E 02	.616E 02	.169E 02	.166E 04	.427E 02	.188E 03
1000.0	.435E 02	11.2	.308E 03	.107E 03	.608E 02	.168E 02	.218E 04	.413E 02	.212E 03
1500.0	.542E 02	9.4	.390E 03	.133E 03	.645E 02	.185E 02	.309E 04	.393E 02	.240E 03
2000.0	.661E 02	8.4	.480E 03	.163E 03	.711E 02	.209E 02	.402E 04	.389E 02	.265E 03
3000.0	.913E 02	7.5	.669E 03	.226E 03	.875E 02	.269E 02	.590E 04	.410E 02	.315E 03
5000.0	.144E 03	6.8	.106E 04	.357E 03	.125E 03	.401E 02	.970E 04	.503E 02	.427E 03
8000.0	.224E 03	6.4	.165E 04	.557E 03	.186E 03	.609E 02	.154E 05	.582E 02	.608E 03



TABLE 15 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0      ECCENTRICITY RATIO = .5

$\bar{F}$	$\phi$	KXX	KYY	KXY	KYA	BXX	BYY	BXY
.1	90.	.000E 00	.000E 00	.483E 00	.725E 00	.000E 00	.967E 00	.000E 00
.2	90.	.000E 00	.000E 00	.967E 00	.145E 01	.000E 00	.193E 01	.000E 00
.4	88.4	.291E 00	.848E 00	.313E 01	.168E 01	.330E 01	.675E 01	.734E 00
.6	84.6	.810E 00	.208E 01	.405E 01	.210E 01	.448E 01	.878E 01	.197E 01
.8	81.0	.138E 01	.312E 01	.509E 01	.242E 01	.588E 01	.106E 02	.321E 01
1.0	78.0	.203E 01	.417E 01	.623E 01	.265E 01	.747E 01	.117E 02	.437E 01
1.5	72.2	.337E 01	.645E 01	.923E 01	.317E 01	.119E 02	.141E 02	.694E 01
2.0	68.1	.594E 01	.841E 01	.123E 02	.366E 01	.168E 02	.162E 02	.916E 01
4.0	58.7	.158E 02	.147E 02	.242E 02	.579E 01	.382E 02	.224E 02	.164E 02
6.0	53.5	.259E 02	.199E 02	.350E 02	.796E 01	.606E 02	.266E 02	.224E 02
8.0	49.8	.316E 02	.243E 02	.445E 02	.989E 01	.828E 02	.296E 02	.276E 02
10.0	47.0	.503E 02	.283E 02	.529E 02	.116E 02	.105E 03	.319E 02	.323E 02
15.0	42.0	.731E 02	.367E 02	.696E 02	.149E 02	.157E 03	.359E 02	.423E 02
20.0	38.6	.102E 03	.433E 02	.809E 02	.169E 02	.204E 03	.384E 02	.506E 02
25.0	36.1	.135E 03	.493E 02	.906E 02	.188E 02	.250E 03	.404E 02	.578E 02
30.0	34.1	.143E 03	.537E 02	.962E 02	.196E 02	.291E 03	.418E 02	.641E 02
40.0	31.2	.176E 03	.617E 02	.106E 03	.212E 02	.369E 03	.439E 02	.750E 02
50.0	29.1	.206E 03	.689E 02	.114E 03	.228E 02	.443E 03	.457E 02	.845E 02
70.0	26.1	.243E 03	.771E 02	.119E 03	.230E 02	.564E 03	.479E 02	.100E 03
100.0	23.2	.289E 03	.872E 02	.123E 03	.236E 02	.731E 03	.499E 02	.119E 03
150.0	20.3	.360E 03	.104E 03	.133E 03	.258E 02	.100E 04	.521E 02	.143E 03
200.0	18.6	.373E 03	.105E 03	.126E 03	.239E 02	.116E 04	.548E 02	.165E 03
400.0	14.5	.459E 03	.132E 03	.126E 03	.242E 02	.193E 04	.562E 02	.220E 03
700.0	11.8	.554E 03	.146E 03	.116E 03	.222E 02	.276E 04	.572E 02	.276E 03
1000.0	10.2	.655E 03	.170E 03	.118E 03	.232E 02	.367E 04	.555E 02	.311E 03
1500.0	8.7	.851E 03	.219E 03	.130E 03	.271E 02	.525E 04	.543E 02	.358E 03
2000.0	7.9	.106E 04	.271E 03	.147E 03	.320E 02	.686E 04	.554E 02	.402E 03
3000.0	7.1	.150E 04	.381E 03	.188E 03	.429E 02	.101E 05	.616E 02	.494E 03
5000.0	6.6	.240E 04	.607E 03	.277E 03	.664E 02	.167E 05	.800E 02	.695E 03
8000.0	6.3	.377E 04	.953E 03	.418E 03	.103E 03	.265E 05	.112E 03	.102E 04





TABLE 16 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0 ECCENTRICITY RATIO = .6

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BXY	BXY
.1	.368E 00	90.	.000E 00	.000E 00	.613E 00	.134E 01	.000E 00	.123E 01	.000E 00
.2	.727E 00	88.5	.200E 00	.865E 00	.274E 01	.110E 01	.216E 01	.575E 01	.549E 00
.4	.137E 01	80.5	.117E 01	.320E 01	.456E 01	.146E 01	.409E 01	.876E 01	.275E 01
.6	.196E 01	74.4	.250E 01	.522E 01	.673E 01	.148E 01	.671E 01	.104E 02	.485E 01
.8	.254E 01	69.9	.406E 01	.690E 01	.902E 01	.142E 01	.969E 01	.119E 02	.674E 01
1.0	.311E 01	66.6	.576E 01	.839E 01	.113E 02	.136E 01	.129E 02	.133E 02	.846E 01
1.5	.452E 01	61.1	.104E 02	.116E 02	.170E 02	.131E 01	.213E 02	.163E 02	.123E 02
2.0	.590E 01	57.6	.154E 02	.145E 02	.225E 02	.142E 01	.300E 02	.191E 02	.156E 02
4.0	.112E 02	50.3	.372E 02	.242E 02	.434E 02	.282E 01	.665E 02	.280E 02	.268E 02
6.0	.161E 02	46.3	.607E 02	.322E 02	.624E 02	.489E 01	.104E 03	.344E 02	.362E 02
8.0	.207E 02	43.5	.849E 02	.393E 02	.796E 02	.707E 01	.142E 03	.392E 02	.445E 02
10.0	.249E 02	41.4	.109E 03	.457E 02	.952E 02	.916E 01	.179E 03	.431E 02	.520E 02
15.0	.339E 02	37.4	.157E 03	.593E 02	.127E 03	.136E 02	.270E 03	.499E 02	.682E 02
20.0	.412E 02	34.6	.21E 03	.705E 02	.152E 03	.170E 02	.355E 03	.543E 02	.817E 02
25.0	.475E 02	32.5	.270E 03	.803E 02	.171E 03	.197E 02	.436E 03	.579E 02	.936E 02
30.0	.528E 02	30.8	.313E 03	.834E 02	.186E 03	.217E 02	.513E 03	.603E 02	.104E 03
40.0	.619E 02	28.3	.391E 03	.103E 03	.210E 03	.249E 02	.657E 03	.643E 02	.122E 03
50.0	.690E 02	26.5	.455E 03	.114E 03	.226E 03	.271E 02	.788E 03	.675E 02	.138E 03
70.0	.795E 02	23.8	.555E 03	.131E 03	.244E 03	.292E 02	.102E 04	.713E 02	.164E 03
100.0	.912E 02	21.2	.670E 03	.150E 03	.260E 03	.311E 02	.134E 04	.751E 02	.196E 03
150.0	.108E 03	18.7	.827E 03	.177E 03	.280E 03	.348E 02	.182E 04	.804E 02	.240E 03
200.0	.111E 03	17.1	.877E 03	.183E 03	.270E 03	.326E 02	.215E 04	.843E 02	.276E 03
400.0	.140E 03	13.4	.117E 04	.252E 03	.278E 03	.347E 02	.359E 04	.884E 02	.373E 03
700.0	.160E 03	10.9	.137E 04	.265E 03	.265E 03	.334E 02	.524E 04	.900E 02	.469E 03
1000.0	.190E 03	9.5	.166E 04	.315E 03	.277E 03	.368E 02	.704E 04	.886E 02	.533E 03
1500.0	.249E 03	8.2	.219E 04	.412E 03	.316E 03	.456E 02	.101E 05	.895E 02	.623E 03
2000.0	.311E 03	7.5	.276E 04	.515E 03	.366E 03	.560E 02	.133E 05	.940E 02	.712E 03
3000.0	.440E 03	6.9	.393E 04	.709E 03	.477E 03	.782E 02	.196E 05	.109E 03	.900E 03
5000.0	.706E 03	6.5	.634E 04	.117E 04	.719E 03	.125E 03	.323E 05	.148E 03	.130E 04
8000.0	.111E 04	6.3	.978E 04	.184E 04	.110E 04	.196E 03	.515E 05	.213E 03	.194E 04





TABLE 17 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 2.0 ECCENTRICITY RATIO = .7

$\frac{F}{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	87.1	.233E 00	.120E 01	.275E 01	.737E 00	.153E 01	.564E 01	.653E 00
.2	77.2	.143E 01	.407E 01	.494E 01	.574E 00	.342E 01	.795E 01	.299E 01
.4	65.1	.530E 01	.753E 01	.102E 02	-.521E 00	.921E 01	.106E 02	.712E 01
.6	53.9	.100E 02	.108E 02	.154E 02	-.149E 01	.159E 02	.126E 02	.105E 02
.8	55.0	.101E 02	.132E 02	.204E 02	-.226E 01	.228E 02	.145E 02	.135E 02
1.0	52.4	.203E 02	.154E 02	.252E 02	-.286E 01	.298E 02	.163E 02	.163E 02
1.5	48.4	.339E 02	.206E 02	.368E 02	-.396E 01	.476E 02	.205E 02	.225E 02
2.0	46.0	.476E 02	.254E 02	.481E 02	-.470E 01	.656E 02	.246E 02	.283E 02
4.0	41.4	.105E 03	.427E 02	.910E 02	-.575E 01	.139E 03	.388E 02	.486E 02
6.0	38.9	.154E 03	.579E 02	.131E 03	-.512E 01	.214E 03	.501E 02	.664E 02
8.0	37.0	.224E 03	.715E 02	.168E 03	-.363E 01	.289E 03	.592E 02	.825E 02
10.0	35.5	.285E 03	.838E 02	.203E 03	-.172E 01	.365E 03	.667E 02	.971E 02
15.0	32.7	.435E 03	.111E 03	.278E 03	.358E 01	.551E 03	.805E 02	.129E 03
20.0	30.6	.577E 03	.133E 03	.340E 03	.876E 01	.731E 03	.902E 02	.156E 03
25.0	28.9	.709E 03	.153E 03	.391E 03	.130E 02	.903E 03	.976E 02	.180E 03
30.0	27.6	.834E 03	.170E 03	.435E 03	.170E 02	.107E 04	.103E 03	.201E 03
40.0	25.5	.106E 04	.201E 03	.506E 03	.238E 02	.139E 04	.112E 03	.238E 03
50.0	23.9	.154E 04	.225E 03	.552E 03	.277E 02	.168E 04	.119E 03	.271E 03
70.0	21.6	.157E 04	.265E 03	.623E 03	.342E 02	.222E 04	.128E 03	.325E 03
100.0	19.4	.194E 04	.309E 03	.683E 03	.401E 02	.295E 04	.136E 03	.391E 03
150.0	17.3	.242E 04	.367E 03	.753E 03	.433E 02	.402E 04	.150E 03	.485E 03
200.0	15.7	.283E 04	.387E 03	.741E 03	.457E 02	.482E 04	.157E 03	.560E 03
400.0	12.4	.352E 04	.502E 03	.797E 03	.541E 02	.815E 04	.169E 03	.769E 03
700.0	10.2	.439E 04	.589E 03	.796E 03	.558E 02	.121E 05	.174E 03	.973E 03
1000.0	8.9	.540E 04	.711E 03	.844E 03	.665E 02	.164E 05	.175E 03	.112E 04
1500.0	7.8	.725E 04	.942E 03	.993E 03	.902E 02	.237E 05	.183E 03	.134E 04
2000.0	7.3	.919E 04	.119E 04	.117E 04	.116E 03	.310E 05	.193E 03	.155E 04
3000.0	6.8	.132E 05	.169E 04	.156E 04	.171E 03	.459E 05	.238E 03	.202E 04
5000.0	6.4	.213E 05	.272E 04	.239E 04	.282E 03	.759E 05	.335E 03	.299E 04
8000.0	6.2	.337E 05	.429E 04	.368E 04	.450E 03	.121E 06	.493E 03	.452E 04



TABLE 18

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 3.0      ECCENTRICITY RATIO = .1

$\overline{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	90.	.000E 00	.000E 00	.319E 00	.169E 00	.000E 00	.538E 00	.000E 00
.2	90.	.000E 00	.000E 00	.638E 00	.338E 00	.000E 00	.128E 01	.000E 00
.4	90.	.000E 00	.000E 00	.128E 01	.676E 00	.000E 00	.255E 01	.000E 00
.6	90.	.000E 00	.000E 00	.191E 01	.101E 01	.000E 00	.383E 01	.000E 00
.8	90.	.000E 00	.000E 00	.255E 01	.135E 01	.000E 00	.510E 01	.000E 00
1.0	90.	.000E 00	.000E 00	.319E 01	.169E 01	.000E 00	.638E 01	.000E 00
1.5	90.	.000E 00	.000E 00	.478E 01	.254E 01	.000E 00	.956E 01	.000E 00
2.0	90.	.000E 00	.000E 00	.638E 01	.338E 01	.000E 00	.128E 02	.000E 00
4.0	90.	.000E 00	.000E 00	.128E 02	.676E 01	.000E 00	.255E 02	.000E 00
6.0	90.	.000E 00	.000E 00	.191E 02	.101E 02	.000E 00	.383E 02	.000E 00
8.0	89.8	.222E 00	.332E 00	.238E 02	.231E 02	.452E 02	.517E 02	.459E 00
10.0	88.8	.290E 00	.730E 00	.264E 02	.256E 02	.511E 02	.610E 02	.756E 00
15.0	84.5	.135E 01	.251E 01	.331E 02	.318E 02	.642E 02	.758E 02	.359E 01
20.0	80.3	.400E 01	.569E 01	.397E 02	.376E 02	.784E 02	.843E 02	.878E 01
25.0	76.7	.750E 01	.926E 01	.457E 02	.426E 02	.927E 02	.904E 02	.147E 02
30.0	73.6	.114E 02	.130E 02	.509E 02	.467E 02	.107E 03	.946E 02	.207E 02
40.0	68.6	.194E 02	.203E 02	.592E 02	.528E 02	.134E 03	.102E 03	.323F 02
50.0	64.8	.271E 02	.270E 02	.654E 02	.572E 02	.159E 03	.106E 03	.425E 02
70.0	59.1	.425E 02	.398E 02	.739E 02	.625E 02	.205E 03	.107E 03	.578E 02
100.0	53.3	.523E 02	.524E 02	.814E 02	.666E 02	.267E 03	.108E 03	.761E 02
150.0	47.2	.725E 02	.680E 02	.863E 02	.684E 02	.354E 03	.110E 03	.994E 02
200.0	43.2	.930E 02	.786E 02	.890E 02	.685E 02	.429E 03	.112E 03	.118E 03
400.0	34.7	.128E 03	.104E 03	.880E 02	.661E 02	.676E 03	.115E 03	.169E 03
700.0	28.7	.155E 03	.123E 03	.837E 02	.616E 02	.967E 03	.117E 03	.218E 03
1000.0	25.1	.152E 03	.142E 03	.839E 02	.612E 02	.126E 04	.115E 03	.252E 03
1500.0	22.3	.137E 03	.145E 03	.755E 02	.547E 02	.154E 04	.119E 03	.298E 03
2000.0	20.1	.199E 03	.154E 03	.715E 02	.515E 02	.186E 04	.119E 03	.334E 03
3000.0	17.0	.230E 03	.176E 03	.690E 02	.496E 02	.250E 04	.115E 03	.385E 03
5000.0	14.1	.250E 03	.191E 03	.614E 02	.440E 02	.345E 04	.113E 03	.461E 03
8000.0	11.3	.303E 03	.233E 03	.604E 02	.433E 02	.504E 04	.103E 03	.526E 03



TABLE 19 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 3.0 ECCENTRICITY RATIO = .2

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.668E-01	90.	.000E 00	.000E 00	.334E 00	.209F 00	.000E 00	.668E 00	.000E 00
.2	.134E 00	90.	.000E 00	.000E 00	.668E 00	.417E 00	.000E 00	.134E 01	.000E 00
.4	.267E 00	90.	.000E 00	.000E 00	.134E 01	.835E 00	.000E 00	.267E 01	.000E 00
.6	.401E 00	90.	.000E 00	.000E 00	.200E 01	.125E 01	.000E 00	.401E 01	.000E 00
.8	.534E 00	90.	.000E 00	.000E 00	.267E 01	.167E 01	.000E 00	.534E 01	.000E 00
1.0	.668E 00	90.	.000E 00	.000E 00	.334E 01	.209E 01	.000E 00	.668E 01	.000E 00
1.5	.100E 01	90.	.000E 00	.000E 00	.501E 01	.313E 01	.000E 00	.100E 02	.000E 00
2.0	.134E 01	90.	.000E 00	.000E 00	.668E 01	.417E 01	.000E 00	.134E 02	.000E 00
4.0	.265E 01	89.4	.596E 00	.919E 00	.127E 02	.115E 02	.228E 02	.287E 02	.126E 01
6.0	.379E 01	86.3	.150E 01	.265E 01	.158E 02	.141E 02	.284E 02	.378E 02	.343E 01
8.0	.476E 01	82.7	.268E 01	.454E 01	.192E 02	.168E 02	.350E 02	.437E 02	.605E 01
10.0	.559E 01	79.4	.424E 01	.651E 01	.227E 02	.194E 02	.422E 02	.479E 02	.896E 01
15.0	.727E 01	72.9	.922E 01	.114E 02	.309E 02	.249E 02	.611E 02	.557E 02	.165E 02
20.0	.856E 01	68.0	.150E 02	.163E 02	.380E 02	.290E 02	.797E 02	.590E 02	.232E 02
25.0	.959E 01	64.1	.210E 02	.209E 02	.437E 02	.320E 02	.974E 02	.606E 02	.290E 02
30.0	.104E 02	60.9	.268E 02	.250E 02	.484E 02	.342E 02	.114E 03	.520E 02	.342E 02
40.0	.118E 02	56.1	.373E 02	.321E 02	.554E 02	.373E 02	.146E 03	.640E 02	.431E 02
50.0	.129E 02	52.5	.488E 02	.331E 02	.606E 02	.394E 02	.175E 03	.655E 02	.508E 02
70.0	.144E 02	47.4	.621E 02	.473E 02	.669E 02	.415E 02	.227E 03	.678E 02	.635E 02
100.0	.160E 02	42.4	.797E 02	.572E 02	.719E 02	.427E 02	.296E 03	.701E 02	.787E 02
150.0	.178E 02	37.2	.100E 03	.684E 02	.751E 02	.429E 02	.395E 03	.723E 02	.980E 02
200.0	.190E 02	33.9	.115E 03	.763E 02	.763E 02	.427E 02	.480E 03	.739E 02	.113E 03
400.0	.216E 02	26.8	.149E 03	.936E 02	.742E 02	.399E 02	.758E 03	.764E 02	.156E 03
700.0	.238E 02	22.3	.175E 03	.107E 03	.707E 02	.375E 02	.108E 04	.785E 02	.197E 03
1000.0	.246E 02	19.7	.177E 03	.113E 03	.660E 02	.346E 02	.134E 04	.796E 02	.228E 03
1500.0	.279E 02	16.7	.220E 03	.131E 03	.649E 02	.340E 02	.182E 04	.772E 02	.264E 03
2000.0	.283E 02	15.1	.226E 03	.133E 03	.603E 02	.314E 01	.214E 04	.779E 02	.295E 03
3000.0	.310E 02	12.8	.253E 03	.148E 03	.568E 02	.296E 02	.285E 04	.750E 02	.337E 03
5000.0	.396E 02	10.1	.331E 03	.192E 03	.585E 02	.309E 02	.438E 04	.680E 02	.388E 03
8000.0	.548E 02	8.4	.456E 03	.259E 03	.690E 02	.367E 02	.675E 04	.648E 02	.448E 03





TABLE 20 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 3.0 ECCENTRICITY RATIO = .3

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.109E 00	90.	.000E 00	.000E 00	.362E 00	.238E 00	.000E 00	.723E 00	.000E 00
.2	.217E 00	90.	.000E 00	.000E 00	.723E 00	.576E 00	.000E 00	.145E 01	.000E 00
.4	.434E 00	90.	.000E 00	.000E 00	.145E 01	.115E 01	.000E 00	.289E 01	.000E 00
.6	.651E 00	90.	.000E 00	.000E 00	.217E 01	.173E 01	.000E 00	.434E 01	.000E 00
.8	.868E 00	90.	.000E 00	.000E 00	.289E 01	.231E 01	.000E 00	.579E 01	.000E 00
1.0	.109E 01	90.	.000E 00	.000E 00	.362E 01	.238E 01	.000E 00	.723E 01	.000E 00
1.5	.163E 01	90.	.000E 00	.000E 00	.543E 01	.432E 01	.000E 00	.109E 02	.000E 00
2.0	.216E 01	89.7	.330E 00	.689E 00	.838E 01	.662E 01	.131E 02	.180E 02	.834E 00
4.0	.403E 01	84.3	.226E 01	.417E 01	.124E 02	.965E 01	.200E 02	.290E 02	.514E 01
6.0	.557E 01	79.0	.439E 01	.736E 01	.171E 02	.125E 02	.287E 02	.360E 02	.933E 01
8.0	.690E 01	74.7	.702E 01	.103E 02	.220E 02	.151E 02	.384E 02	.409E 02	.134E 02
10.0	.808E 01	71.1	.102E 02	.133E 02	.269E 02	.175E 02	.486E 02	.433E 02	.170E 02
15.0	.106E 02	64.3	.191E 02	.199E 02	.377E 02	.223E 02	.743E 02	.477E 02	.251E 02
20.0	.125E 02	59.5	.285E 02	.257E 02	.466E 02	.257E 02	.990E 02	.507E 02	.321E 02
25.0	.142E 02	55.9	.376E 02	.307E 02	.538E 02	.283E 02	.123E 03	.529E 02	.382E 02
30.0	.155E 02	52.9	.461E 02	.352E 02	.596E 02	.301E 02	.145E 03	.547E 02	.437E 02
40.0	.179E 02	48.6	.620E 02	.429E 02	.688E 02	.331E 02	.187E 03	.574E 02	.533E 02
50.0	.195E 02	45.3	.732E 02	.490E 02	.747E 02	.346E 02	.225E 03	.592E 02	.615E 02
70.0	.222E 02	40.8	.975E 02	.587E 02	.827E 02	.365E 02	.295E 03	.620E 02	.751E 02
100.0	.248E 02	36.3	.122E 03	.636E 02	.882E 02	.373E 02	.384E 03	.645E 02	.914E 02
150.0	.279E 02	31.3	.151E 03	.803E 03	.926E 02	.378E 02	.513E 03	.673E 02	.112E 03
200.0	.299E 02	28.9	.171E 03	.882E 02	.935E 02	.374E 02	.626E 03	.689E 02	.129E 03
400.0	.366E 02	22.7	.232E 03	.112E 03	.962E 02	.375E 02	.103E 04	.709E 02	.174E 03
700.0	.377E 02	19.0	.251E 03	.118E 03	.856E 02	.326E 02	.140E 04	.749E 02	.223E 03
1000.0	.420E 02	16.5	.298E 03	.133E 03	.846E 02	.322E 02	.183E 04	.738E 02	.255E 03
1500.0	.444E 02	14.3	.311E 03	.142E 03	.786E 02	.299E 02	.235E 04	.743E 02	.298E 03
2000.0	.475E 02	12.7	.333E 03	.153E 03	.756E 02	.288E 02	.288E 04	.728E 02	.329E 03
3000.0	.565E 02	10.6	.410E 03	.134E 03	.762E 02	.294E 02	.400E 04	.584E 02	.371E 03
5000.0	.785E 02	8.6	.579E 03	.257E 03	.871E 02	.349E 02	.634E 04	.546E 02	.434E 03
8000.0	.115E 03	7.4	.853E 03	.377E 03	.111E 03	.458E 02	.991E 04	.681E 02	.528E 03









TABLE 22 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 3.0 ECCENTRICITY RATIO = .5

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.242E 00	90.	.000E 00	.000E 00	.433E 00	.725E 00	.000E 00	.967E 00	.000E 00
.2	.483E 00	90.	.000F 00	.000E 00	.967E 00	.145E 01	.000E 00	.193E 01	.000E 00
.4	.967E 00	90.	.000E 00	.000F 00	.193E 01	.290E 01	.000E 00	.387E 01	.000E 00
.6	.145E 01	89.8	.144F 00	.519E 00	.539E 01	.279E 01	.550E 01	.111E 02	.375E 00
.8	.190E 01	88.4	.543E 00	.178E 01	.625E 01	.337E 01	.660E 01	.135E 02	.147E 01
1.0	.234E 01	86.6	.109F 01	.302E 01	.713E 01	.382E 01	.772E 01	.156E 02	.269E 01
1.5	.335E 01	81.9	.247E 01	.575E 01	.965E 01	.469E 01	.110E 02	.203E 02	.581E 01
2.0	.430E 01	78.0	.406E 01	.834E 01	.125E 02	.532E 01	.149E 02	.235E 02	.875E 01
4.0	.782E 01	68.1	.119E 02	.168E 02	.246E 02	.731E 01	.337E 02	.324E 02	.183E 02
6.0	.111E 02	62.5	.212E 02	.236E 02	.367E 02	.939E 01	.546E 02	.393E 02	.260E 02
8.0	.142E 02	53.7	.315E 02	.295E 02	.484E 02	.116E 02	.765E 02	.449E 02	.328E 02
10.0	.171E 02	55.8	.425E 02	.348E 02	.595E 02	.138E 02	.988E 02	.494E 02	.390E 02
15.0	.237E 02	50.6	.714E 02	.465E 02	.846E 02	.189E 02	.155E 03	.580E 02	.528E 02
20.0	.294E 02	47.0	.101E 03	.566E 02	.106E 03	.232E 02	.209E 03	.539E 02	.647E 02
25.0	.343E 02	44.2	.129E 03	.653E 02	.123E 03	.267E 02	.262E 03	.681E 02	.751E 02
30.0	.388E 02	42.0	.156E 03	.735E 02	.139E 03	.299E 02	.314E 03	.719E 02	.847E 02
40.0	.449E 02	38.6	.205E 03	.866E 02	.162E 03	.339E 02	.409E 03	.768E 02	.101E 03
50.0	.523E 02	36.1	.250E 03	.986E 02	.181E 03	.377E 02	.501E 03	.809E 02	.116E 03
70.0	.612E 02	32.5	.321E 03	.116E 03	.203E 03	.411E 02	.662E 03	.860E 02	.140E 03
100.0	.725E 02	29.1	.411E 03	.138F 03	.228E 03	.456E 02	.886E 03	.914E 02	.169E 03
150.0	.829E 02	25.5	.507E 03	.159E 03	.241E 03	.468E 02	.119E 04	.966E 02	.207E 03
200.0	.905E 02	23.2	.578E 03	.174E 03	.247E 03	.472E 02	.146E 04	.999E 02	.238E 03
400.0	.109E 03	18.6	.747E 03	.211E 03	.251E 03	.478E 02	.232E 04	.110E 03	.330E 03
700.0	.127E 03	15.2	.913E 03	.249E 03	.248E 03	.472E 02	.346E 04	.112E 03	.418E 03
1000.0	.137E 03	13.4	.101E 04	.259E 03	.240E 03	.459E 02	.437E 04	.115E 03	.485E 03
1500.0	.152E 03	11.5	.114E 04	.259E 03	.231E 03	.445E 02	.582E 04	.114E 03	.565E 03
2000.0	.172E 03	10.2	.131E 04	.341E 03	.235E 03	.465E 02	.735E 04	.111E 03	.623E 03
3000.0	.221E 03	8.7	.170F 04	.438E 03	.260E 03	.541E 02	.105E 05	.109E 03	.715E 03
5000.0	.328E 03	7.4	.256E 04	.651E 03	.334E 03	.746E 02	.170F 05	.116E 03	.894E 03
8000.0	.497E 03	6.8	.370E 04	.907E 03	.463E 03	.109E 03	.268E 05	.140E 03	.118E 04



TABLE 23 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 3.0 ECCENTRICITY RATIO = .6

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.368E 00	90.	.000E 00	.000E 00	.613E 00	.134E 01	.000E 00	.123E 01	.000E 00
.2	.736E 00	90.	.000E 00	.000E 00	.123E 01	.268E 01	.000E 00	.245E 01	.000E 00
.4	.145E 01	88.5	.399E 00	.173E 01	.548E 01	.220E 01	.432E 01	.115E 02	.110E 01
.6	.211E 01	84.4	.127E 01	.413E 01	.718E 01	.270E 01	.605E 01	.150E 02	.324E 01
.8	.273E 01	80.5	.235E 01	.640E 01	.911E 01	.292E 01	.819E 01	.175E 02	.550E 01
1.0	.334E 01	77.2	.360E 01	.853E 01	.112E 02	.298E 01	.107E 02	.193E 02	.766E 01
1.5	.480E 01	70.9	.730E 01	.130E 02	.169E 02	.287E 01	.179E 02	.231E 02	.126E 02
2.0	.623E 01	66.6	.115E 02	.168E 02	.226E 02	.272E 01	.258E 02	.265E 02	.169E 02
4.0	.118E 02	57.6	.308E 02	.290E 02	.450E 02	.283E 01	.600E 02	.381E 02	.312E 02
6.0	.172E 02	53.2	.520E 02	.392E 02	.664E 02	.395E 01	.960E 02	.478E 02	.430E 02
8.0	.224E 02	50.3	.744E 02	.483E 02	.868E 02	.565E 01	.133E 03	.559E 02	.536E 02
10.0	.275E 02	48.1	.975E 02	.567E 02	.106E 03	.765E 01	.171E 03	.628E 02	.633E 02
15.0	.392E 02	44.2	.158E 03	.752E 02	.151E 03	.131E 02	.265E 03	.763E 02	.851E 02
20.0	.498E 02	41.4	.218E 03	.914E 02	.190E 03	.183E 02	.359E 03	.862E 02	.104E 03
25.0	.592E 02	39.1	.278E 03	.106E 03	.224E 03	.230E 02	.450E 03	.935E 02	.121E 03
30.0	.678E 02	37.4	.335E 03	.119E 03	.254E 03	.272E 02	.540E 03	.997E 02	.136E 03
40.0	.825E 02	34.6	.442E 03	.141E 03	.303E 03	.340E 02	.711E 03	.109E 03	.163E 03
50.0	.951E 02	32.5	.539E 03	.161E 03	.342E 03	.394E 02	.873E 03	.116E 03	.187E 03
70.0	.115E 03	29.4	.705E 03	.191E 03	.396E 03	.465E 02	.117E 04	.125E 03	.227E 03
100.0	.138E 03	26.5	.909E 03	.228E 03	.452E 03	.542E 02	.158E 04	.135E 03	.276E 03
150.0	.163E 03	23.3	.115E 04	.269E 03	.495E 03	.592E 02	.216E 04	.144E 03	.341E 03
200.0	.182E 03	21.2	.134E 04	.300E 03	.519E 03	.622E 02	.268E 04	.150E 03	.392E 03
400.0	.223E 03	17.1	.175E 04	.367E 03	.540E 03	.652E 02	.430E 04	.169E 03	.552E 03
700.0	.271E 03	14.0	.224E 04	.448E 03	.558E 03	.691E 02	.655E 04	.175E 03	.705E 03
1000.0	.290E 03	12.4	.244E 04	.479E 03	.537E 03	.667E 02	.822E 04	.180E 03	.823E 03
1500.0	.330E 03	10.6	.283E 04	.545E 03	.531E 03	.675E 02	.111E 05	.179E 03	.962E 03
2000.0	.381E 03	9.5	.332E 04	.630E 03	.553E 03	.735E 02	.141E 05	.177E 03	.107E 04
3000.0	.497E 03	8.2	.439E 04	.823E 03	.632E 03	.912E 02	.203E 05	.179E 03	.125E 04
5000.0	.750E 03	7.2	.609E 04	.124E 04	.840E 03	.134E 03	.328E 05	.202E 03	.161E 04
8000.0	.114E 04	6.6	.103E 05	.190E 04	.119E 04	.203E 03	.519E 05	.255E 03	.220E 04





TABLE 24 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 3.0 ECCENTRICITY RATIO = .7

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.603E 00	90.	.000E 00	.000E 00	.862E 00	.292E 01	.000E 00	.172E 01	.000E 00
.2	.118E 01	87.1	.466E 00	.240E 01	.550E 01	.147E 01	.307E 01	.113E 02	.131E 01
.4	.224E 01	77.2	.286E 01	.814E 01	.988E 01	.115E 01	.684E 01	.159E 02	.599E 01
.6	.327E 01	70.0	.639E 01	.124E 02	.151E 02	.897E-01	.123E 02	.188E 02	.103E 02
.8	.429E 01	65.1	.106E 02	.159E 02	.204E 02	.104E 01	.184E 02	.212E 02	.142E 02
1.0	.532E 01	61.6	.152E 02	.189E 02	.256E 02	.207E 01	.250F 02	.233E 02	.178E 02
1.5	.788E 01	55.9	.276E 02	.252E 02	.333E 02	.417E 01	.420E 02	.281E 02	.256E 02
2.0	.104E 02	52.4	.407F 02	.309E 02	.504E 02	.573E 01	.596E 02	.326E 02	.325E 02
4.0	.206E 02	46.0	.952E 02	.507E 02	.962E 02	.939E 01	.131E 03	.491E 02	.566E 02
6.0	.306E 02	43.2	.151E 03	.687E 02	.140E 03	.110E 02	.204E 03	.542E 02	.777E 02
8.0	.405E 02	41.4	.209E 03	.854E 02	.182E 03	.115E 02	.278E 03	.776E 02	.973E 02
10.0	.501E 02	40.0	.268E 03	.101E 03	.223E 03	.112E 02	.352E 03	.896E 02	.116E 03
15.0	.734E 02	37.4	.418E 03	.136E 03	.319E 03	.811E 01	.541E 03	.114E 03	.157E 03
20.0	.951E 02	35.5	.570E 03	.168E 03	.406E 03	.344E 01	.730E 03	.133E 03	.194E 03
25.0	.115E 03	34.0	.721F 03	.196E 03	.435E 03	.190E 01	.917E 03	.148E 03	.227E 03
30.0	.134E 03	32.7	.869E 03	.221E 03	.556E 03	.716E 01	.110E 04	.161E 03	.258E 03
40.0	.168E 03	30.6	.115E 04	.267E 03	.681E 03	.175E 02	.146E 04	.180E 03	.312E 03
50.0	.197E 03	28.9	.142E 04	.306E 03	.782E 03	.261E 02	.181E 04	.195E 03	.360F 03
70.0	.246E 03	26.4	.139E 04	.371E 03	.940E 03	.403E 02	.246E 04	.216E 03	.440E 03
100.0	.304F 03	23.9	.249E 04	.449E 03	.110E 04	.553E 02	.335E 04	.238E 03	.542E 03
150.0	.373E 03	21.2	.326E 04	.543E 03	.126E 04	.695E 02	.468E 04	.259E 03	.674E 03
200.0	.428E 03	19.4	.389E 04	.618E 03	.137E 04	.802E 02	.590E 04	.273E 03	.782E 03
400.0	.539E 03	15.7	.526E 04	.774E 03	.148E 04	.913E 02	.964E 04	.314E 03	.112E 04
700.0	.694E 03	13.0	.639E 04	.977E 03	.161E 04	.109E 03	.150E 05	.332E 03	.144E 04
1000.0	.734E 03	11.5	.766E 04	.105E 04	.156E 04	.106E 03	.188E 05	.345E 03	.170E 04
1500.0	.852E 03	9.9	.909E 04	.122E 04	.158E 04	.114E 03	.256E 05	.348E 03	.200E 04
2000.0	.999E 03	8.9	.103E 05	.142E 04	.169E 04	.133E 03	.327E 05	.349E 03	.224E 04
3000.0	.132E 04	7.8	.145E 05	.188E 04	.199E 04	.180E 03	.473E 05	.366E 03	.267E 04
5000.0	.202E 04	6.9	.224E 05	.287E 04	.272E 04	.287E 03	.769E 05	.434E 03	.356E 04
8000.0	.310E 04	6.5	.345E 05	.441E 04	.394E 04	.453E 03	.122E 06	.571E 03	.500E 04





TABLE 25 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 4.0			ECCENTRICITY RATIO = .1				
$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY	
.1	90.	.000E 00	.000E 00	.319E 00	.169E 00	.000E 00	.538E 00	.000E 00	
.2	90.	.000E 00	.000E 00	.638E 00	.338E 00	.000E 00	.128E 01	.000E 00	
.4	90.	.000E 00	.000E 00	.128E 01	.676E 00	.000E 00	.255E 01	.000E 00	
.6	90.	.000E 00	.000E 00	.191E 01	.101E 01	.000E 00	.383F 01	.000E 00	
.8	90.	.000E 00	.000E 00	.255E 01	.135E 01	.000E 00	.510E 01	.000E 00	
1.0	90.	.000E 00	.000E 00	.319E 01	.169E 01	.000E 00	.638E 01	.000E 00	
1.5	90.	.000E 00	.000E 00	.478E 01	.254E 01	.000E 00	.956E 01	.000E 00	
2.0	90.	.000E 00	.000E 00	.638E 01	.338E 01	.000E 00	.128F 02	.000E 00	
4.0	90.	.000E 00	.000E 00	.128E 02	.676E 01	.000E 00	.255E 02	.000E 00	
6.0	90.	.000E 00	.000E 00	.191F 02	.101E 02	.000E 00	.383E 02	.000E 00	
8.0	90.	.000E 00	.000E 00	.255F 02	.135E 02	.000E 00	.510F 02	.000E 00	
10.0	-89.9	.674E-01	.777E-01	.325F 02	.316E 02	.632E 02	.656E 02	.136E 00	
15.0	88.8	.435E 00	.109E 01	.395F 02	.383E 02	.766E 02	.915E 02	.113E 01	
20.0	86.0	.124E 01	.280E 01	.462E 02	.446E 02	.895E 02	.107E 03	.351E 01	
25.0	83.1	.310E 01	.526E 01	.530E 02	.508E 02	.103E 03	.119E 03	.769E 01	
30.0	80.3	.600E 01	.853E 01	.595E 02	.564E 02	.118E 03	.126E 03	.132E 02	
40.0	75.6	.132F 02	.158E 02	.712F 02	.660E 02	.146E 03	.138E 03	.251E 02	
50.0	71.8	.212E 02	.233E 02	.809E 02	.735E 02	.174E 03	.146E 03	.370E 02	
70.0	66.0	.359E 02	.372E 02	.956F 02	.841E 02	.227E 03	.159E 03	.592E 02	
100.0	59.9	.587E 02	.556E 02	.110E 03	.931F 02	.298E 03	.160E 03	.832E 02	
150.0	53.3	.874E 02	.786E 02	.122E 03	.999E 02	.401E 03	.163E 03	.114E 03	
200.0	48.9	.108E 03	.948E 02	.127E 03	.102E 03	.489E 03	.165E 03	.139E 03	
400.0	39.4	.152E 03	.134E 03	.133E 03	.102E 03	.780E 03	.170E 03	.207E 03	
700.0	33.0	.203F 03	.163E 03	.130E 03	.971E 02	.112E 04	.174E 03	.272E 03	
1000.0	29.2	.228E 03	.181E 03	.126E 03	.929E 02	.140E 04	.176E 03	.320E 03	
1500.0	25.1	.273E 03	.213E 03	.126E 03	.918E 02	.190E 04	.173E 03	.378E 03	
2000.0	23.2	.277E 03	.216E 03	.117E 03	.847E 02	.217E 04	.178E 03	.425E 03	
3000.0	20.1	.299E 03	.231E 03	.107E 03	.773E 02	.278E 04	.179E 03	.501E 03	
5000.0	16.5	.347E 03	.265E 03	.100E 03	.721E 02	.397E 04	.173E 03	.601E 03	
8000.0	13.7	.324E 03	.292E 03	.914E 02	.654E 02	.543E 04	.168E 03	.705E 03	



TABLE 26

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 4.0                      ECCENTRICITY RATIO = .2

$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	90.	.000E 00	.000E 00	.334E 00	.209E 00	.000E 00	.668E 00	.000E 00
.2	90.	.000E 00	.000E 00	.668E 00	.417E 00	.000E 00	.134E 01	.000E 00
.4	90.	.000E 00	.000E 00	.134E 01	.835E 00	.000E 00	.267E 01	.000E 00
.6	90.	.000E 00	.000E 00	.200E 01	.125E 01	.000E 00	.401E 01	.000E 00
.8	90.	.000E 00	.000E 00	.267E 01	.167E 01	.000E 00	.534E 01	.000E 00
1.0	90.	.000E 00	.000E 00	.334E 01	.209E 01	.000E 00	.668E 01	.000E 00
1.5	90.	.000E 00	.000E 00	.501E 01	.313E 01	.000E 00	.100E 02	.000E 00
2.0	90.	.000E 00	.000E 00	.668E 01	.417E 01	.000E 00	.134E 02	.000E 00
4.0	90.	.000E 00	.000E 00	.134E 02	.835E 01	.000E 00	.267E 02	.000E 00
6.0	89.4	.895E 00	.138E 01	.191E 02	.172E 02	.342E 02	.430E 02	.190E 01
8.0	87.4	.178E 01	.309E 01	.221E 02	.199E 02	.397E 02	.528E 02	.400E 01
10.0	85.1	.279E 01	.494E 01	.253E 02	.225E 02	.457E 02	.599E 02	.643E 01
15.0	79.4	.636E 01	.977E 01	.340E 02	.290E 02	.633E 02	.719E 02	.134E 02
20.0	74.8	.112E 02	.147E 02	.425E 02	.348E 02	.821E 02	.801E 02	.210E 02
25.0	71.0	.166E 02	.196E 02	.501E 02	.395E 02	.101E 03	.865E 02	.285E 02
30.0	68.0	.226E 02	.245E 02	.569E 02	.434E 02	.120E 03	.886E 02	.348E 02
40.0	63.0	.344E 02	.335E 02	.681E 02	.493E 02	.155E 03	.917E 02	.461E 02
50.0	59.1	.457E 02	.413E 02	.766E 02	.532E 02	.188E 03	.940E 02	.560E 02
70.0	53.6	.655E 02	.542E 02	.885E 02	.581E 02	.248E 03	.975E 02	.725E 02
100.0	43.1	.893E 02	.689E 02	.992E 02	.619E 02	.329E 03	.101E 03	.924E 02
150.0	42.4	.119E 03	.858E 02	.108E 03	.641E 02	.444E 03	.105E 03	.118E 03
200.0	38.6	.141E 03	.975E 02	.111E 03	.643E 02	.544E 03	.108E 03	.138E 03
400.0	30.8	.193E 03	.125E 03	.113E 03	.623E 02	.869E 03	.113E 03	.195E 03
700.0	25.3	.240E 03	.149E 03	.112E 03	.599E 02	.123E 04	.114E 03	.249E 03
1000.0	22.6	.262E 03	.160E 03	.107E 03	.570E 02	.158E 04	.117E 03	.289E 03
1500.0	19.7	.281E 03	.169E 03	.990E 02	.520E 02	.200E 04	.119E 03	.342E 03
2000.0	17.5	.312E 03	.186E 03	.971E 02	.508E 02	.248E 04	.117E 03	.380E 03
3000.0	15.1	.339E 03	.200E 03	.904E 02	.471E 02	.321E 04	.117E 03	.442E 03
5000.0	12.2	.397E 03	.232E 03	.848E 02	.443E 02	.465E 04	.110E 03	.522E 03
8000.0	9.9	.518E 03	.300E 03	.890E 02	.471E 02	.696E 04	.101E 03	.593E 03



TABLE 27 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 4.0			ECCENTRICITY RATIO = .3				
	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
1	.109E 00	90.	.000E 00	.000E 00	.362E 00	.238E 00	.000E 00	.723E 00	.000E 00
2	.217E 00	90.	.000E 00	.000E 00	.723E 00	.576E 00	.000E 00	.145E 01	.000E 00
4	.434E 00	90.	.000E 00	.000E 00	.145E 01	.115E 01	.000E 00	.289E 01	.000E 00
6	.651E 00	90.	.000E 00	.000E 00	.217E 01	.173E 01	.000E 00	.434E 01	.000E 00
8	.868E 00	90.	.000E 00	.000E 00	.289E 01	.231E 01	.000E 00	.579E 01	.000E 00
10	.109E 01	90.	.000E 00	.000E 00	.362E 01	.288E 01	.000E 00	.723E 01	.000E 00
15	.163E 01	90.	.000E 00	.000E 00	.543E 01	.432E 01	.000E 00	.109E 02	.000E 00
20	.217E 01	90.	.000E 00	.000E 00	.723E 01	.576E 01	.000E 00	.145E 02	.000E 00
40	.425E 01	88.3	.151E 01	.275E 01	.145F 02	.116E 02	.229E 02	.337E 02	.338E 01
60	.604E 01	84.3	.339E 01	.625E 01	.186E 02	.145E 02	.299E 02	.435E 02	.771E 01
80	.762E 01	80.6	.545E 01	.951E 01	.233E 02	.173E 02	.384E 02	.508E 02	.119E 02
100	.905E 01	77.4	.730E 01	.125E 02	.281E 02	.201E 02	.478E 02	.570E 02	.161E 02
150	.121E 02	71.1	.153E 02	.199E 02	.403E 02	.262E 02	.729E 02	.650E 02	.255E 02
200	.147E 02	66.3	.240E 02	.267E 02	.515E 02	.312E 02	.986E 02	.697E 02	.338E 02
250	.169E 02	62.5	.323E 02	.328E 02	.613E 02	.353E 02	.124E 03	.732E 02	.413E 02
300	.188E 02	59.5	.427E 02	.385E 02	.700E 02	.386F 02	.149E 03	.761E 02	.481E 02
400	.220E 02	54.9	.609E 02	.485E 02	.842E 02	.437E 02	.196E 03	.835E 02	.602E 02
500	.245E 02	51.3	.774E 02	.568E 02	.944F 02	.468E 02	.239E 03	.880E 02	.707E 02
700	.284E 02	46.3	.106E 03	.704E 02	.109E 03	.510E 02	.319E 03	.924E 02	.884E 02
1000	.329E 02	41.4	.142E 03	.863E 02	.123E 03	.548E 02	.427E 03	.968E 02	.110E 03
1500	.373E 02	36.3	.193E 03	.103E 03	.132E 03	.560E 02	.576E 03	.995E 02	.137E 03
2000	.412E 02	33.0	.218E 03	.117E 03	.140F 03	.577E 02	.718E 03	.105E 03	.159E 03
4000	.477E 02	26.2	.296E 03	.143E 03	.139E 03	.547E 02	.114E 04	.105E 03	.221E 03
7000	.545E 02	21.7	.350E 03	.168E 03	.138E 03	.535E 02	.165E 04	.109E 03	.280E 03
10000	.560E 02	19.3	.371E 03	.175E 03	.129E 03	.493E 02	.203E 04	.112E 03	.327E 03
15000	.630E 02	16.5	.432E 03	.200E 03	.127E 03	.483E 02	.274E 04	.111E 03	.382E 03
20000	.656E 02	14.9	.458E 03	.210E 03	.121E 03	.459E 02	.327E 04	.111E 03	.427E 03
30000	.712E 02	12.7	.507E 03	.230E 03	.113E 03	.432E 02	.431E 04	.109E 03	.493E 03
50000	.898E 02	10.1	.555E 03	.293E 03	.116E 03	.451E 02	.659E 04	.101E 03	.574E 03
80000	.124E 03	8.4	.913E 03	.405E 03	.134E 03	.538E 02	.101E 05	.969E 02	.666E 03





TABLE 28

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 4.0				ECCENIRICITY RATIO = .4			
$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY	
.1	90.	.000E 00	.000E 00	.408E 00	.437E 00	.000E 00	.816E 00	.000E 00	
.2	90.	.000E 00	.000E 00	.816E 00	.874E 00	.000E 00	.163E 01	.000E 00	
.4	90.	.000E 00	.000E 00	.163E 01	.175E 01	.000E 00	.326E 01	.000E 00	
.6	90.	.000E 00	.000E 00	.245E 01	.262E 01	.000E 00	.489E 01	.000E 00	
.8	90.	.000E 00	.000E 00	.326E 01	.350E 01	.000E 00	.553E 01	.000E 00	
1.0	90.	.000E 00	.000E 00	.408E 01	.437E 01	.000E 00	.816E 01	.000E 00	
1.5	-90.0	.149E 00	.394E 00	.923E 01	.597E 01	.119E 02	.188E 02	.355E 00	
2.0	89.0	.865E 00	.200E 01	.106E 02	.713E 01	.140E 02	.234E 02	.203E 01	
4.0	82.4	.409E 01	.821E 01	.166E 02	.105E 02	.231E 02	.367E 02	.935E 01	
6.0	77.0	.773E 01	.136E 02	.236E 02	.133E 02	.347E 02	.459E 02	.160E 02	
8.0	72.9	.120E 02	.186E 02	.310E 02	.159E 02	.477E 02	.514E 02	.217E 02	
10.0	69.6	.169E 02	.231E 02	.385E 02	.184E 02	.616E 02	.561E 02	.269E 02	
15.0	63.4	.308E 02	.330E 02	.565E 02	.242E 02	.979E 02	.549E 02	.384E 02	
20.0	58.9	.452E 02	.416E 02	.726E 02	.291E 02	.135E 03	.712E 02	.487E 02	
25.0	55.6	.620E 02	.494E 02	.870E 02	.333E 02	.171E 03	.761E 02	.579E 02	
30.0	52.8	.778E 02	.563E 02	.994E 02	.366E 02	.206E 03	.797E 02	.663E 02	
40.0	48.6	.108E 03	.686E 02	.120E 03	.420E 02	.273E 03	.855E 02	.811E 02	
50.0	45.6	.136E 03	.794E 02	.137E 03	.463E 02	.337E 03	.899E 02	.940E 02	
70.0	41.0	.184E 03	.961E 02	.158E 03	.508E 02	.452E 03	.955E 02	.116E 03	
100.0	36.7	.242E 03	.115E 03	.178E 03	.548E 02	.606E 03	.101E 03	.142E 03	
150.0	32.2	.318E 03	.139E 03	.198E 03	.589E 02	.836E 03	.107E 03	.177E 03	
200.0	29.4	.365E 03	.153E 03	.204E 03	.589E 02	.102E 04	.111E 03	.204E 03	
400.0	23.2	.504E 03	.194E 03	.214E 03	.599E 02	.168E 04	.118E 03	.282E 03	
700.0	19.5	.586E 03	.217E 03	.206E 03	.566E 02	.236E 04	.126E 03	.363E 03	
1000.0	17.1	.651E 03	.236E 03	.199E 03	.544E 02	.301E 04	.128E 03	.422E 03	
1500.0	14.7	.752E 03	.267E 03	.196E 03	.539E 02	.402E 04	.128E 03	.494E 03	
2000.0	13.2	.794E 03	.278E 03	.186E 03	.510E 02	.482E 04	.128E 03	.553E 03	
3000.0	11.2	.925E 03	.320E 03	.182E 03	.505E 02	.654E 04	.124E 03	.635E 03	
5000.0	9.0	.126E 04	.429E 03	.200E 03	.577E 02	.102E 05	.117E 03	.745E 03	
8000.0	7.7	.191E 04	.614E 03	.245E 03	.745E 02	.158E 05	.120E 03	.894E 03	





TABLE 29 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 4.0				ECCENTRICITY RATIO = .5			
	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.242E 00	90.	.000E 00	.000E 00	.483E 00	.725E 00	.000E 00	.967E 00	.000E 00
.2	.483E 00	90.	.000E 00	.000E 00	.967E 00	.145E 01	.000E 00	.193E 01	.000E 00
.4	.967E 00	90.	.000E 00	.000E 00	.193E 01	.290E 01	.000E 00	.387E 01	.000E 00
.6	.145E 01	90.	.000E 00	.000E 00	.290E 01	.435E 01	.000E 00	.580E 01	.000E 00
.8	.193E 01	-89.9	.614E-01	.271E 00	.754E 01	.382E 01	.761E 01	.152E 02	.169E 00
1.0	.240E 01	89.5	.419E 00	.141E 01	.852E 01	.449E 01	.882E 01	.179E 02	.107E 01
1.5	.351E 01	86.6	.163E 01	.453E 01	.107E 02	.573E 01	.116E 02	.234E 02	.404E 01
2.0	.453E 01	83.3	.208E 01	.733E 01	.132E 02	.665E 01	.148E 02	.282E 02	.716E 01
4.0	.826E 01	73.9	.967E 01	.172E 02	.246E 02	.902E 01	.312E 02	.401E 02	.184E 02
6.0	.117E 02	68.1	.178E 02	.252E 02	.369E 02	.110E 02	.505E 02	.486E 02	.275E 02
8.0	.150E 02	64.1	.269E 02	.322E 02	.491E 02	.130E 02	.712E 02	.559E 02	.354E 02
10.0	.182E 02	61.1	.368E 02	.385E 02	.610E 02	.152E 02	.927E 02	.520E 02	.426E 02
15.0	.257E 02	55.8	.637E 02	.522E 02	.893E 02	.207E 02	.148E 03	.741E 02	.586E 02
20.0	.324E 02	52.1	.925E 02	.642E 02	.115E 03	.259E 02	.204E 03	.831E 02	.726E 02
25.0	.385E 02	49.2	.122E 03	.749E 02	.138E 03	.306E 02	.260E 03	.900E 02	.853E 02
30.0	.441E 02	47.0	.151E 03	.849E 02	.159E 03	.349E 02	.314E 03	.958E 02	.970E 02
40.0	.537E 02	43.4	.207E 03	.102E 03	.193E 03	.415E 02	.419E 03	.104E 03	.118E 03
50.0	.618E 02	40.7	.259E 03	.117E 03	.220E 03	.467E 02	.518E 03	.110E 03	.136E 03
70.0	.755E 02	36.9	.353E 03	.142E 03	.263E 03	.548E 02	.706E 03	.119E 03	.166E 03
100.0	.900E 02	33.0	.466E 03	.170E 03	.301E 03	.611E 02	.955E 03	.128E 03	.204E 03
150.0	.109E 03	29.1	.617E 03	.207E 03	.342E 03	.684E 02	.133E 04	.137E 03	.254E 03
200.0	.116E 03	26.5	.709E 03	.227E 03	.353E 03	.686E 02	.163E 04	.143E 03	.294E 03
400.0	.154E 03	21.0	.102E 04	.298E 03	.392E 03	.759E 02	.276E 04	.154E 03	.407E 03
700.0	.167E 03	17.7	.116E 04	.326E 03	.370E 03	.700E 02	.384E 04	.167E 03	.530E 03
1000.0	.186E 03	15.5	.134E 04	.365E 03	.370E 03	.702E 02	.499E 04	.169E 03	.615E 03
1500.0	.205E 03	13.4	.151E 04	.404E 03	.360E 03	.688E 02	.656E 04	.172E 03	.727E 03
2000.0	.219E 03	12.0	.163E 04	.431E 03	.348E 03	.667E 02	.798E 04	.172E 03	.813E 03
3000.0	.259E 03	10.2	.197E 04	.511E 03	.353E 03	.697E 02	.110E 05	.167E 03	.934E 03
5000.0	.357E 03	8.4	.276E 04	.708E 03	.406E 03	.859E 02	.174E 05	.163E 03	.111E 04
8000.0	.520E 03	7.3	.406E 04	.103E 04	.521E 03	.117E 03	.271E 05	.177E 03	.139E 04



TABLE 30

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 4.0				ECCENTRICITY RATIO = .6			
	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.368E 00	90.	.000E 00	.000E 00	.613E 00	.134E 01	.000E 00	.123E 01	.000E 00
.2	.736E 00	90.	.000E 00	.000E 00	.123E 01	.268E 01	.000E 00	.245E 01	.000E 00
.4	.147E 01	-89.9	.448E-02	.107E 00	.654E 01	.245E 01	.488E 01	.131E 02	.290E-01
.6	.218E 01	88.5	.599E 00	.260E 01	.821E 01	.330E 01	.648E 01	.173E 02	.165E 01
.8	.285E 01	85.8	.144E 01	.505E 01	.988E 01	.386E 01	.814E 01	.208E 02	.374E 01
1.0	.348E 01	83.0	.240E 01	.728E 01	.117E 02	.421E 01	.101E 02	.241E 02	.599E 01
1.5	.500E 01	77.2	.541E 01	.128E 02	.169E 02	.446E 01	.160E 02	.289E 02	.115E 02
2.0	.647E 01	72.8	.899E 01	.174E 02	.225E 02	.438E 01	.230E 02	.329E 02	.165E 02
4.0	.122E 02	62.6	.265E 02	.318E 02	.453E 02	.392E 01	.553E 02	.460E 02	.332E 02
6.0	.177E 02	57.6	.453E 02	.435E 02	.676E 02	.425E 01	.900E 02	.572E 02	.468E 02
8.0	.231E 02	54.4	.672E 02	.539E 02	.890E 02	.525E 01	.126E 03	.571E 02	.589E 02
10.0	.284E 02	52.1	.890E 02	.635E 02	.110E 03	.671E 01	.162E 03	.759E 02	.700E 02
15.0	.412E 02	48.1	.146E 03	.850E 02	.159E 03	.115E 02	.256E 03	.942E 02	.950E 02
20.0	.531E 02	45.3	.206E 03	.104E 03	.205E 03	.169E 02	.350E 03	.108E 03	.117E 03
25.0	.642E 02	43.1	.257E 03	.121E 03	.247E 03	.223E 02	.445E 03	.120E 03	.137E 03
30.0	.746E 02	41.4	.327E 03	.137E 03	.286E 03	.275E 02	.538E 03	.129E 03	.156E 03
40.0	.933E 02	38.5	.446E 03	.165E 03	.353E 03	.369E 02	.721E 03	.144E 03	.189E 03
50.0	.109E 03	36.3	.557E 03	.190E 03	.408E 03	.444E 02	.896E 03	.154E 03	.219E 03
70.0	.138E 03	33.2	.765E 03	.233E 03	.499E 03	.577E 02	.123E 04	.171E 03	.270E 03
100.0	.168E 03	29.8	.102E 04	.280E 03	.583E 03	.683E 02	.168E 04	.185E 03	.331E 03
150.0	.207E 03	26.5	.136E 04	.342E 03	.678E 03	.813E 02	.236E 04	.203E 03	.415E 03
200.0	.233E 03	24.2	.161E 04	.384E 03	.722E 03	.860E 02	.295E 04	.212E 03	.481E 03
400.0	.319E 03	19.3	.243E 04	.524E 03	.851E 03	.107E 03	.512E 04	.235E 03	.677E 03
700.0	.346E 03	16.2	.277E 04	.571E 03	.805E 03	.968E 02	.716E 04	.257E 03	.889E 03
1000.0	.397E 03	14.3	.327E 04	.655E 03	.829E 03	.102E 03	.943E 04	.261E 03	.104E 04
1500.0	.435E 03	12.4	.365E 04	.719E 03	.806E 03	1.000E 02	.123E 05	.270E 03	.123E 04
2000.0	.472E 03	11.1	.403E 04	.780E 03	.793E 03	.997E 02	.151E 05	.270E 03	.138E 04
3000.0	.571E 03	9.5	.497E 04	.946E 03	.830E 03	.110E 03	.211E 05	.266E 03	.160E 04
5000.0	.807E 03	7.9	.714E 04	.134E 04	.995E 03	.147E 03	.335E 05	.272E 03	.196E 04
8000.0	.119E 04	7.1	.106E 05	.197E 04	.132E 04	.212E 03	.524E 05	.310E 03	.251E 04



TABLE 31 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 4.0				ECCENTRICITY RATIO = .7			
	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	RXX	BYX	BXY
.1	.603E 00	90.	.000E 00	.000E 00	.862E 00	.292E 01	.000E 00	.172E 01	.000E 00
.2	.121E 01	89.9	.475E-01	.518E 00	.648E 01	.171E 01	.338E 01	.130E 02	.173E 00
.4	.232E 01	83.6	.165E 01	.662E 01	.101E 02	.232E 01	.609E 01	.202E 02	.427E 01
.6	.336E 01	77.2	.428E 01	.122E 02	.148E 02	.172E 01	.103E 02	.238E 02	.898E 01
.8	.439E 01	72.1	.768E 01	.166E 02	.200E 02	.708E 00	.155F 02	.269E 02	.134E 02
1.0	.541E 01	68.2	.116E 02	.204E 02	.253E 02	-.441E 00	.214E 02	.295E 02	.175E 02
1.5	.797E 01	61.6	.228E 02	.283E 02	.385E 02	-.311E 01	.374E 02	.350E 02	.267E 02
2.0	.105E 02	57.4	.351E 02	.348E 02	.512E 02	-.531F 01	.544E 02	.398E 02	.347E 02
4.0	.207E 02	49.5	.879E 02	.567E 02	.990E 02	-.109E 02	.125E 03	.574E 02	.616E 02
6.0	.309E 02	46.0	.143E 03	.761E 02	.144E 03	-.141E 02	.197E 03	.737E 02	.848E 02
8.0	.409E 02	44.0	.199E 03	.943E 02	.188E 03	-.159E 02	.269E 03	.890E 02	.106E 03
10.0	.509E 02	42.5	.256E 03	.112E 03	.231E 03	-.169E 02	.343E 03	.103E 03	.127E 03
15.0	.752E 02	40.0	.402E 03	.152E 03	.334E 03	-.167E 02	.529E 03	.134E 03	.173E 03
20.0	.987E 02	38.2	.551E 03	.188E 03	.431E 03	-.141E 02	.717E 03	.160E 03	.216E 03
25.0	.121E 03	36.8	.703E 03	.221E 03	.523E 03	-.998E 01	.906E 03	.182E 03	.255E 03
30.0	.143E 03	35.5	.855E 03	.251E 03	.609E 03	-.517E 01	.109E 04	.200E 03	.291E 03
40.0	.183E 03	33.6	.116E 04	.307E 03	.766E 03	.566E 01	.147E 04	.230E 03	.357E 03
50.0	.219E 03	31.9	.145E 04	.355E 03	.900E 03	.161E 02	.183F 04	.252E 03	.415E 03
70.0	.283E 03	29.5	.200E 04	.441E 03	.113E 04	.358E 02	.254E 04	.287E 03	.518E 03
100.0	.358E 03	26.8	.273E 04	.542E 03	.137E 04	.572E 02	.353E 04	.319E 03	.642E 03
150.0	.456E 03	23.9	.373E 04	.674E 03	.166E 04	.830E 02	.503E 04	.357E 03	.813E 03
200.0	.529E 03	21.9	.454E 04	.773E 03	.183E 04	.984E 02	.638E 04	.379E 03	.950E 03
400.0	.759E 03	17.8	.713E 04	.109E 04	.229E 04	.151E 03	.113E 05	.437E 03	.137E 04
700.0	.849E 03	14.9	.840E 04	.122E 04	.224E 04	.138E 03	.162E 05	.480E 03	.181E 04
1000.0	.998E 03	13.2	.102E 05	.143E 04	.238E 04	.159E 03	.215E 05	.495E 03	.212E 04
1500.0	.110E 04	11.5	.115E 05	.157E 04	.234F 04	.158E 03	.282E 05	.517E 03	.255E 04
2000.0	.121E 04	10.3	.129E 05	.173E 04	.235E 04	.165E 03	.350E 05	.521E 03	.286E 04
3000.0	.150E 04	8.9	.162E 05	.213E 04	.253E 04	.199E 03	.491E 05	.524E 03	.336E 04
5000.0	.216E 04	7.6	.237E 05	.307E 04	.315E 04	.296E 03	.783E 05	.562E 03	.422E 04
8000.0	.321E 04	6.9	.355E 05	.456E 04	.428E 04	.458E 03	.123E 06	.572E 03	.558E 04





TABLE 32 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 5.0 ECCENTRICITY RATIO = .1

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.319E-01	90.	.000E 00	.000E 00	.319E 00	.169E 00	.000E 00	.538E 00	.000E 00
.2	.638E-01	90.	.000E 00	.000E 00	.638E 00	.338E 00	.000E 00	.128E 01	.000E 00
.4	.128E 00	90.	.000E 00	.000E 00	.128E 01	.676E 00	.000E 00	.255E 01	.000E 00
.6	.191E 00	90.	.000E 00	.000E 00	.191E 01	.101E 01	.000F 00	.383E 01	.000E 00
.8	.255E 00	90.	.000E 00	.000E 00	.255E 01	.135E 01	.000E 00	.510E 01	.000E 00
1.0	.319E 00	90.	.000E 00	.000E 00	.319E 01	.169E 01	.000E 00	.538E 01	.000E 00
1.5	.478E 00	90.	.000E 00	.000E 00	.478E 01	.254E 01	.000E 00	.956E 01	.000E 00
2.0	.638E 00	90.	.000E 00	.000E 00	.638E 01	.338E 01	.000E 00	.128E 02	.000E 00
4.0	.128E 01	90.	.000E 00	.000E 00	.128E 02	.676E 01	.000E 00	.255E 02	.000E 00
6.0	.191E 01	90.	.000E 00	.000E 00	.191E 02	.101E 02	.000E 00	.383E 02	.000E 00
8.0	.255E 01	90.	.000E 00	.000E 00	.255E 02	.135E 02	.000E 00	.510E 02	.000E 00
10.0	.319E 01	90.	.000E 00	.000E 00	.319E 02	.169E 02	.000E 00	.538E 02	.000E 00
15.0	.478E 01	90.0	.371E 00	.485F 00	.462E 02	.449E 02	.897E 02	.977E 02	.753E 00
20.0	.626E 01	88.8	.580E 00	.146E 01	.527E 02	.511E 02	.102E 03	.122E 03	.151E 01
25.0	.756E 01	86.7	.124E 01	.304E 01	.593E 02	.573E 02	.115E 03	.139E 03	.358E 01
30.0	.870E 01	84.5	.270E 01	.522E 01	.662E 02	.636E 02	.128E 03	.152E 03	.718E 01
40.0	.106E 02	80.3	.800E 01	.114E 02	.794E 02	.753E 02	.157E 03	.169E 03	.176E 02
50.0	.121E 02	76.7	.150E 02	.185E 02	.913E 02	.852E 02	.185E 03	.181E 03	.294E 02
70.0	.143E 02	71.0	.309E 02	.335E 02	.111E 03	.100E 03	.241E 03	.197E 03	.531E 02
100.0	.167E 02	64.8	.543E 02	.540E 02	.131E 03	.114E 03	.319E 03	.212E 03	.850E 02
150.0	.192E 02	58.0	.834E 02	.825E 02	.151E 03	.127E 03	.432E 03	.215E 03	.122E 03
200.0	.210E 02	53.3	.117E 03	.105E 03	.163E 03	.133E 03	.535E 03	.217E 03	.152E 03
400.0	.246E 02	43.2	.186E 03	.157E 03	.176E 03	.137E 03	.858E 03	.224E 03	.235E 03
700.0	.277E 02	36.1	.248E 03	.202E 03	.180E 03	.136E 03	.126E 04	.228E 03	.316E 03
1000.0	.288E 02	32.2	.278E 03	.223E 03	.173E 03	.129E 03	.156E 04	.232E 03	.375E 03
1500.0	.307E 02	28.0	.318E 03	.251E 03	.167E 03	.122E 03	.203E 04	.234E 03	.448E 03
2000.0	.336E 02	25.1	.363E 03	.284E 03	.168E 03	.122E 03	.253E 04	.231E 03	.503E 03
3000.0	.334E 02	22.3	.374E 03	.291E 03	.151E 03	.109E 03	.309E 04	.239E 03	.596E 03
5000.0	.367E 02	18.3	.432E 03	.332E 03	.140E 03	.101E 03	.439E 04	.234E 03	.724E 03
8000.0	.391E 02	15.4	.474E 03	.362E 03	.128E 03	.917E 02	.591E 04	.230E 03	.856E 03





TABLE 33

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

		PRESSURE RATIO = 5.0		ECCENTRICITY RATIO = .2					
	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.668E-01	90.	.000E 00	.000E 00	.334E 00	.209E 00	.000E 00	.668E 00	.000E 00
.2	.134E 00	90.	.000E 00	.000E 00	.668E 00	.417E 00	.000E 00	.134E 01	.000E 00
.4	.267E 00	90.	.000E 00	.000E 00	.134E 01	.835E 00	.000E 00	.267E 01	.000E 00
.6	.401E 00	90.	.000E 00	.000E 00	.200E 01	.125E 01	.000E 00	.401E 01	.000E 00
.8	.534E 00	90.	.000E 00	.000E 00	.267E 01	.167E 01	.000E 00	.534E 01	.000E 00
1.0	.668E 00	90.	.000E 00	.000E 00	.334E 01	.209E 01	.000E 00	.668E 01	.000E 00
1.5	.100E 01	90.	.000E 00	.000E 00	.501E 01	.313E 01	.000E 00	.100E 02	.000E 00
2.0	.134E 01	90.	.000E 00	.000E 00	.668E 01	.417E 01	.000E 00	.134E 02	.000E 00
4.0	.267E 01	90.	.000E 00	.000E 00	.134E 02	.835E 01	.000E 00	.267E 02	.000E 00
6.0	.401E 01	-89.9	.115E 00	.167E 00	.222E 02	.198E 02	.396E 02	.449E 02	.242E 00
8.0	.530E 01	89.4	.119E 01	.184E 01	.255E 02	.229E 02	.456E 02	.574E 02	.253E 01
10.0	.649E 01	88.0	.210E 01	.358E 01	.284E 02	.255E 02	.509E 02	.673E 02	.467E 01
15.0	.907E 01	83.6	.471E 01	.814E 01	.367E 02	.323E 02	.666E 02	.847E 02	.107E 02
20.0	.112E 02	79.4	.848E 01	.130E 02	.453E 02	.387E 02	.843E 02	.958E 02	.179E 02
25.0	.130E 02	75.9	.132E 02	.180E 02	.539E 02	.446E 02	.103E 03	.104E 03	.254E 02
30.0	.145E 02	72.9	.184E 02	.229E 02	.619E 02	.497E 02	.122E 03	.111E 03	.330E 02
40.0	.171E 02	68.0	.301E 02	.327E 02	.759E 02	.579E 02	.159E 03	.118E 03	.464E 02
50.0	.192E 02	64.1	.420E 02	.418E 02	.874E 02	.639E 02	.195E 03	.121E 03	.580E 02
70.0	.224E 02	53.3	.646E 02	.576E 02	.105E 03	.722E 02	.261E 03	.126E 03	.776E 02
100.0	.258E 02	52.5	.935E 02	.762E 02	.121E 03	.788E 02	.350E 03	.131E 03	.102E 03
150.0	.295E 02	46.4	.131E 03	.983E 02	.136E 03	.835E 02	.479E 03	.136E 03	.133E 03
200.0	.321E 02	42.4	.159E 03	.114E 03	.144E 03	.854E 02	.592E 03	.140E 03	.157E 03
400.0	.380E 02	33.9	.231E 03	.153E 03	.153E 03	.855E 02	.961E 03	.148E 03	.226E 03
700.0	.420E 02	23.1	.233E 03	.179E 03	.149E 03	.806E 02	.138E 04	.152E 03	.294E 03
1000.0	.466E 02	24.6	.332E 03	.206E 03	.150E 03	.803E 02	.180E 04	.152E 03	.341E 03
1500.0	.476E 02	21.8	.353E 03	.215E 03	.139E 03	.735E 02	.223E 04	.158E 03	.405E 03
2000.0	.492E 02	19.7	.374E 03	.226E 03	.132E 03	.693E 02	.267E 04	.159E 03	.456E 03
3000.0	.558E 02	16.7	.439E 03	.261E 03	.130E 03	.680E 02	.364E 04	.154E 03	.528E 03
5000.0	.588E 02	13.8	.476E 03	.260E 03	.116E 03	.603E 02	.497E 04	.154E 03	.637E 03
8000.0	.700E 02	11.2	.530E 03	.338E 03	.114E 03	.596E 02	.721E 04	.142E 03	.732E 03



TABLE 34

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 5.0      ECCENTRICITY RATIO = .3

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.109E 00	90.	.000E 00	.000E 00	.362E 00	.288E 00	.000E 00	.723E 00	.000E 00
.2	.217E 00	90.	.000E 00	.000E 00	.723E 00	.576E 00	.000E 00	.145E 01	.000E 00
.4	.434E 00	90.	.000E 00	.000E 00	.145E 01	.115E 01	.000E 00	.289E 01	.000E 00
.6	.651E 00	90.	.000E 00	.000E 00	.217E 01	.173E 01	.000E 00	.434E 01	.000E 00
.8	.868E 00	90.	.000E 00	.000E 00	.289E 01	.231E 01	.000E 00	.579E 01	.000E 00
1.0	.109E 01	90.	.000E 00	.000E 00	.362E 01	.288E 01	.000E 00	.723E 01	.000E 00
1.5	.163E 01	90.	.000E 00	.000E 00	.543E 01	.432E 01	.000E 00	.109E 02	.000E 00
2.0	.217E 01	90.	.000E 00	.000E 00	.723E 01	.576E 01	.000E 00	.145E 02	.000E 00
4.0	.433E 01	89.7	.761E 00	.138E 01	.168E 02	.132E 02	.263E 02	.360E 02	.167E 01
6.0	.629E 01	87.3	.266E 01	.491E 01	.206E 02	.164E 02	.327E 02	.484E 02	.600E 01
8.0	.805E 01	84.3	.452E 01	.834E 01	.248E 02	.193E 02	.399E 02	.580E 02	.103E 02
10.0	.965E 01	81.5	.654E 01	.116E 02	.294E 02	.222E 02	.482E 02	.555E 02	.145E 02
15.0	.132E 02	75.6	.126E 02	.191E 02	.416E 02	.290E 02	.719E 02	.803E 02	.249E 02
20.0	.162E 02	71.1	.204E 02	.265E 02	.537E 02	.350E 02	.972E 02	.866E 02	.340E 02
25.0	.188E 02	67.4	.290E 02	.334E 02	.650E 02	.401E 02	.123E 03	.915E 02	.424E 02
30.0	.211E 02	64.3	.382E 02	.398E 02	.755E 02	.446E 02	.149E 03	.954E 02	.501E 02
40.0	.251E 02	59.5	.569E 02	.513E 02	.933E 02	.515E 02	.198E 03	.101E 03	.641E 02
50.0	.283E 02	55.9	.751E 02	.614E 02	.108E 03	.565E 02	.245E 03	.106E 03	.765E 02
70.0	.334E 02	50.5	.103E 03	.783E 02	.129E 03	.633E 02	.333E 03	.112E 03	.975E 02
100.0	.391E 02	45.3	.150E 03	.980E 02	.149E 03	.691E 02	.450E 03	.118E 03	.123E 03
150.0	.453E 02	39.9	.203E 03	.121E 03	.167E 03	.732E 02	.619E 03	.125E 03	.156E 03
200.0	.497E 02	36.3	.243E 03	.137E 03	.176E 03	.746E 02	.768E 03	.129E 03	.183E 03
400.0	.599E 02	28.9	.343E 03	.176E 03	.187E 03	.747E 02	.125E 04	.138E 03	.258E 03
700.0	.697E 02	23.8	.435E 03	.213E 03	.190E 03	.739E 02	.186E 04	.141E 03	.330E 03
1000.0	.727E 02	21.3	.470E 03	.225E 03	.181E 03	.700E 02	.228E 04	.147E 03	.386E 03
1500.0	.766E 02	18.5	.513E 03	.241E 03	.170E 03	.648E 02	.293E 04	.150E 03	.458E 03
2000.0	.840E 02	16.5	.576E 03	.267E 03	.169E 03	.645E 02	.365E 04	.148E 03	.510E 03
3000.0	.888E 02	14.3	.623E 03	.285E 03	.157E 03	.597E 02	.469E 04	.149E 03	.595E 03
5000.0	.103E 03	11.5	.744E 03	.335E 03	.150E 03	.576E 02	.686E 04	.141E 03	.704E 03
8000.0	.134E 03	9.4	.934E 03	.439E 03	.162E 03	.634E 02	.103E 05	.131E 03	.807E 03



TABLE 35 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 5.0 ECCENTRICITY RATIO = .4

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	KXX	KYY	BXX	BYY	BXY
.1	.163E 00	90.	.000E 00	.000E 00	.408E 00	.437E 00	.000E 00	.816E 00	.000E 00	.816E 00	.000E 00
.2	.326E 00	90.	.000E 00	.000E 00	.816E 00	.874E 00	.000E 00	.163E 01	.000E 00	.163E 01	.000E 00
.4	.653E 00	90.	.000E 00	.000E 00	.163E 01	.175E 01	.000E 00	.326E 01	.000E 00	.326E 01	.000E 00
.6	.979E 00	90.	.000E 00	.000E 00	.245E 01	.262E 01	.000E 00	.489E 01	.000E 00	.489E 01	.000E 00
.8	.131E 01	90.	.000E 00	.000E 00	.326E 01	.350E 01	.000E 00	.553E 01	.000E 00	.553E 01	.000E 00
1.0	.163E 01	90.	.000E 00	.000E 00	.408E 01	.437E 01	.000E 00	.816E 01	.000E 00	.816E 01	.000E 00
1.5	.245E 01	90.	.000E 00	.000E 00	.612E 01	.656E 01	.000E 00	.122E 02	.000E 00	.122E 02	.000E 00
2.0	.326E 01	-90.0	.199E 00	.526E 00	.123E 02	.796F 01	.158E 02	.251E 02	.158E 02	.251E 02	.474E 00
4.0	.622E 01	85.7	.327E 01	.702E 01	.179E 02	.119E 02	.243E 02	.408E 02	.243E 02	.408E 02	.766E 01
6.0	.880E 01	80.9	.658E 01	.128E 02	.244E 02	.150E 02	.344E 02	.527E 02	.344E 02	.527E 02	.148E 02
8.0	.112E 02	77.0	.103E 02	.191E 02	.315E 02	.178E 02	.462E 02	.612E 02	.462E 02	.612E 02	.213E 02
10.0	.134E 02	73.8	.145E 02	.232E 02	.389E 02	.204E 02	.591E 02	.669E 02	.591E 02	.669E 02	.271E 02
15.0	.185E 02	67.8	.269E 02	.343E 02	.575E 02	.266E 02	.941E 02	.781E 02	.941E 02	.781E 02	.399E 02
20.0	.231E 02	63.4	.410E 02	.440E 02	.753E 02	.323E 02	.130E 03	.866E 02	.130E 03	.866E 02	.513E 02
25.0	.272E 02	60.0	.563E 02	.527E 02	.918E 02	.373E 02	.167E 03	.931E 02	.167E 03	.931E 02	.616E 02
30.0	.309E 02	57.1	.721E 02	.607E 02	.107E 03	.416E 02	.204E 03	.983E 02	.204E 03	.983E 02	.712E 02
40.0	.374E 02	52.8	.104E 03	.751E 02	.132E 03	.488E 02	.274E 03	.106E 03	.274E 03	.106E 03	.884E 02
50.0	.429E 02	49.5	.134E 03	.876E 02	.154E 03	.543E 02	.342E 03	.112E 03	.342E 03	.112E 03	.103E 03
70.0	.519E 02	44.9	.190F 03	.109E 03	.186E 03	.623E 02	.469E 03	.137E 03	.469E 03	.137E 03	.129E 03
100.0	.619E 02	40.2	.261E 03	.133E 03	.217E 03	.693E 02	.640E 03	.129E 03	.640E 03	.129E 03	.161E 03
150.0	.734E 02	35.3	.351E 03	.163E 03	.246E 03	.749E 02	.889E 03	.143E 03	.889E 03	.143E 03	.202E 03
200.0	.823E 02	32.2	.424E 03	.185E 03	.264E 03	.784E 02	.111E 04	.154E 03	.111E 04	.143E 03	.235E 03
400.0	.998E 02	25.6	.535E 03	.233E 03	.279E 03	.786E 02	.181E 04	.161E 03	.181E 04	.154E 03	.331E 03
700.0	.120E 03	21.2	.755E 03	.284E 03	.292E 03	.815E 02	.271E 04	.169E 03	.271E 04	.161E 03	.424E 03
1000.0	.122E 03	19.0	.793E 03	.292E 03	.272E 03	.745E 02	.329E 04	.170E 03	.329E 04	.169E 03	.500E 03
1500.0	.136E 03	16.3	.913E 03	.328E 03	.266E 03	.727E 02	.439E 04	.170E 03	.439E 04	.170E 03	.589E 03
2000.0	.146E 03	14.7	.100E 04	.356E 03	.262E 03	.719E 02	.536E 04	.170E 03	.536E 04	.170E 03	.659E 03
3000.0	.157E 03	12.6	.110E 04	.333E 03	.245E 03	.671E 02	.698E 04	.170E 03	.698E 04	.170E 03	.770E 03
5000.0	.194E 03	10.2	.139E 04	.478E 03	.249E 03	.700E 02	.105E 05	.161E 03	.105E 05	.161E 03	.907E 03
8000.0	.264E 03	8.4	.192E 04	.653E 03	.284E 03	.838E 02	.161E 05	.156E 03	.161E 05	.156E 03	.106E 04





TABLE 36 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 5.0      ECCENTRICITY RATIO = .5

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.242E 00	90.	.000E 00	.000E 00	.483E 00	.725E 00	.000E 00	.967E 00	.000E 00
.2	.483E 00	90.	.000E 00	.000E 00	.967E 00	.145E 01	.000E 00	.193E 01	.000E 00
.4	.967E 00	90.	.000E 00	.000E 00	.193E 01	.290E 01	.000E 00	.387E 01	.000E 00
.6	.145E 01	90.	.000E 00	.000E 00	.290E 01	.435E 01	.000E 00	.580E 01	.000E 00
.8	.193E 01	90.	.000E 00	.000E 00	.387E 01	.580E 01	.000E 00	.773E 01	.000E 00
1.0	.242E 01	-89.9	.917E-02	.942E-01	.962E 01	.482E 01	.964E 01	.192E 02	.364E-01
1.5	.359E 01	88.9	.931E 00	.294E 01	.121E 02	.647E 01	.127E 02	.258E 02	.236E 01
2.0	.468E 01	86.6	.217E 01	.603E 01	.143E 02	.765E 01	.154E 02	.312E 02	.538E 01
4.0	.860E 01	78.0	.812E 01	.167E 02	.249E 02	.106E 02	.299E 02	.469E 02	.175E 02
6.0	.122E 02	72.2	.155E 02	.258E 02	.369E 02	.127E 02	.478E 02	.565E 02	.277E 02
8.0	.156E 02	68.1	.238E 02	.336E 02	.492E 02	.146E 02	.674E 02	.648E 02	.367E 02
10.0	.190E 02	65.0	.328E 02	.407E 02	.614E 02	.167E 02	.880E 02	.722E 02	.447E 02
15.0	.269E 02	59.6	.577E 02	.562E 02	.911E 02	.221E 02	.142E 03	.873E 02	.624E 02
20.0	.342E 02	55.8	.850E 02	.696E 02	.119E 03	.276E 02	.198E 03	.989E 02	.781E 02
25.0	.410E 02	52.9	.114E 03	.818E 02	.145E 03	.328E 02	.254E 03	.108E 03	.924E 02
30.0	.474E 02	50.6	.143E 03	.931E 02	.169E 03	.379E 02	.309E 03	.116E 03	.106E 03
40.0	.588E 02	47.0	.201E 03	.113E 03	.212E 03	.465E 02	.419E 03	.128E 03	.129E 03
50.0	.686E 02	44.2	.258E 03	.131E 03	.247E 03	.533E 02	.524E 03	.136E 03	.150E 03
70.0	.849E 02	40.1	.362E 03	.160E 03	.302E 03	.637E 02	.723E 03	.149E 03	.186E 03
100.0	.105E 03	36.1	.500E 03	.197E 03	.362E 03	.753E 02	.100E 04	.162E 03	.231E 03
150.0	.126E 03	31.8	.672E 03	.239E 03	.415E 03	.834E 02	.140E 04	.174E 03	.290E 03
200.0	.145E 03	29.1	.823E 03	.275E 03	.456E 03	.912E 02	.177E 04	.183E 03	.338E 03
400.0	.181E 03	23.2	.116E 04	.349E 03	.493E 03	.945E 02	.292E 04	.200E 03	.476E 03
700.0	.215E 03	19.4	.146E 04	.417E 03	.513E 03	.987E 02	.431E 04	.215E 03	.619E 03
1000.0	.226E 03	17.3	.159E 04	.442E 03	.491E 03	.928E 02	.537E 04	.223E 03	.729E 03
1500.0	.262E 03	14.8	.189E 04	.513E 03	.500E 03	.956E 02	.732E 04	.225E 03	.860E 03
2000.0	.274E 03	13.4	.201E 04	.538E 03	.480E 03	.918E 02	.875E 04	.229E 03	.970E 03
3000.0	.303E 03	11.5	.228E 04	.599E 03	.462E 03	.891E 02	.116E 05	.228E 03	.113E 04
5000.0	.392E 03	9.3	.300E 04	.776E 03	.492E 03	.998E 02	.178E 05	.218E 03	.134E 04
8000.0	.547E 03	7.9	.425E 04	.109E 04	.589E 03	.128E 03	.275E 05	.222E 03	.161E 04





TABLE 37 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 5.0                      ECCENTRICITY RATIO = .6

$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYX	BXY	BYY
.1	90.	.000E 00	.000E 00	.613E 00	.134E 01	.000E 00	.123E 01	.000E 00	.123E 01
.2	90.	.000E 00	.000E 00	.123E 01	.268E 01	.000E 00	.245E 01	.000E 00	.245E 01
.4	90.	.000E 00	.000E 00	.245E 01	.537E 01	.000E 00	.491E 01	.000E 00	.491E 01
.6	89.9	.153E 00	.909E 00	.935E 01	.359E 01	.709E 01	.190E 02	.461E 00	.190E 02
.8	88.5	.799E 00	.346E 01	.110E 02	.440E 01	.864E 01	.230E 02	.220E 01	.230E 02
1.0	86.5	.162E 01	.594E 01	.126E 02	.499E 01	.103E 02	.266E 02	.426E 01	.266E 02
1.5	81.5	.411E 01	.117E 02	.172E 02	.578E 01	.152E 02	.341E 02	.990E 01	.341E 02
2.0	77.2	.721E 01	.171E 02	.225E 02	.595E 01	.214E 02	.385E 02	.153E 02	.385E 02
4.0	66.6	.231E 02	.336E 02	.453E 02	.543E 01	.515E 02	.531E 02	.338E 02	.531E 02
6.0	61.1	.417E 02	.465E 02	.680E 02	.524E 01	.851E 02	.652E 02	.491E 02	.652E 02
8.0	57.6	.617E 02	.580E 02	.901E 02	.567E 01	.120E 03	.762E 02	.624E 02	.762E 02
10.0	55.1	.825E 02	.685E 02	.112E 03	.660E 01	.156E 03	.863E 02	.747E 02	.863E 02
15.0	50.9	.137E 03	.922E 02	.163E 03	.104E 02	.247E 03	.108E 03	.102E 03	.108E 03
20.0	48.1	.195E 03	.113E 03	.212E 03	.153E 02	.341E 03	.126E 03	.127E 03	.126E 03
25.0	45.9	.255E 03	.133E 03	.259E 03	.207E 02	.435E 03	.140E 03	.149E 03	.140E 03
30.0	44.2	.315E 03	.150E 03	.302E 03	.261E 02	.530E 03	.153E 03	.170E 03	.153E 03
40.0	41.4	.436E 03	.183E 03	.381E 03	.367E 02	.717E 03	.172E 03	.208E 03	.172E 03
50.0	39.1	.555E 03	.211E 03	.449E 03	.460E 02	.901E 03	.187E 03	.242E 03	.187E 03
70.0	35.9	.780E 03	.261E 03	.561E 03	.617E 02	.125E 04	.209E 03	.301E 03	.209E 03
100.0	32.5	.108E 04	.321E 03	.685E 03	.789E 02	.175E 04	.231E 03	.374E 03	.231E 03
150.0	28.8	.149E 04	.397E 03	.816E 03	.962E 02	.248E 04	.253E 03	.471E 03	.253E 03
200.0	26.5	.192E 04	.456E 03	.904E 03	.108E 03	.315E 04	.270E 03	.553E 03	.270E 03
400.0	21.2	.268E 04	.601E 03	.104E 04	.124E 03	.536E 04	.300E 03	.784E 03	.300E 03
700.0	17.9	.339E 04	.717E 03	.109E 04	.133E 03	.791E 04	.331E 03	.104E 04	.331E 03
1000.0	15.8	.379E 04	.778E 03	.107E 04	.129E 03	.100E 05	.344E 03	.122E 04	.344E 03
1500.0	13.7	.464E 04	.924E 03	.113E 04	.141E 03	.138E 05	.350E 03	.145E 04	.350E 03
2000.0	12.4	.488E 04	.958E 03	.107E 04	.133E 03	.164E 05	.360E 03	.165E 04	.360E 03
3000.0	10.6	.567E 04	.109E 04	.106E 04	.135E 03	.222E 05	.359E 03	.192E 04	.359E 03
5000.0	8.7	.768E 04	.145E 04	.118E 04	.164E 03	.343E 05	.354E 03	.232E 04	.354E 03
8000.0	7.5	.110E 05	.206E 04	.146E 04	.224E 03	.531E 05	.376E 03	.285E 04	.376E 03



TABLE 38 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 5.0 ECCENTRICITY RATIO = .7

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYX	BXY
.1	.603E 00	90.	.000E 00	.000E 00	.862E 00	.292E 01	.000E 00	.172E 01	.000E 00
.2	.121E 01	90.	.000E 00	.000E 00	.172E 01	.583E 01	.000E 00	.345E 01	.000E 00
.4	.237E 01	87.1	.932E 00	.479E 01	.110E 02	.295E 01	.613E 01	.226E 02	.261E 01
.6	.344E 01	81.9	.296E 01	.109E 02	.150E 02	.300E 01	.933E 01	.282E 02	.727E 01
.8	.448E 01	77.2	.571E 01	.163E 02	.198E 02	.230E 01	.137E 02	.318E 02	.120E 02
1.0	.551E 01	73.2	.903E 01	.209E 02	.249E 02	.127E 01	.188E 02	.348E 02	.165E 02
1.5	.807E 01	66.2	.190E 02	.301E 02	.382E 02	-.153E 01	.337E 02	.413E 02	.266E 02
2.0	.106E 02	61.6	.304E 02	.377E 02	.513E 02	-.415E 01	.499E 02	.466E 02	.355E 02
4.0	.209E 02	52.4	.814E 02	.617E 02	.101E 03	-.115E 02	.119E 03	.551E 02	.651E 02
6.0	.310E 02	48.4	.135E 03	.822E 02	.147E 03	-.159E 02	.190E 03	.821E 02	.901E 02
8.0	.412E 02	46.0	.190E 03	.101E 03	.192E 03	-.188E 02	.262E 03	.983E 02	.113E 03
10.0	.512E 02	44.4	.246E 03	.120E 03	.237E 03	-.208E 02	.335E 03	.114E 03	.135E 03
15.0	.760E 02	41.8	.389E 03	.163E 03	.343E 03	-.229E 02	.519E 03	.149E 03	.185E 03
20.0	.100E 03	40.0	.536E 03	.202E 03	.445E 03	-.223E 02	.705E 03	.179E 03	.231E 03
25.0	.124E 03	38.6	.685E 03	.239E 03	.543E 03	-.199E 02	.893E 03	.206E 03	.274E 03
30.0	.147E 03	37.4	.836E 03	.273E 03	.637E 03	-.162E 02	.108E 04	.228E 03	.314E 03
40.0	.190E 03	35.5	.114E 04	.335E 03	.812E 03	-.689E 01	.146E 04	.267E 03	.388E 03
50.0	.231E 03	34.0	.144E 04	.391E 03	.970E 03	.380E 01	.183E 04	.297E 03	.455E 03
70.0	.303E 03	31.5	.203E 04	.489E 03	.124E 04	.250E 02	.257E 04	.343E 03	.572E 03
100.0	.394E 03	28.9	.234E 04	.611E 03	.156E 04	.521E 02	.361E 04	.390E 03	.719E 03
150.0	.515E 03	25.9	.402E 04	.773E 03	.195E 04	.876E 02	.523E 04	.440E 03	.917E 03
200.0	.608E 03	23.9	.498E 04	.899E 03	.221E 04	.111E 03	.670E 04	.476E 03	.108E 04
400.0	.855E 03	19.4	.778E 04	.124E 04	.273E 04	.160E 03	.118E 05	.546E 03	.156E 04
700.0	.105E 04	16.5	.101E 05	.150E 04	.297E 04	.185E 03	.176E 05	.617E 03	.210E 04
1000.0	.116E 04	14.6	.116E 05	.167E 04	.301E 04	.187E 03	.227E 05	.644E 03	.249E 04
1500.0	.139E 04	12.7	.143E 05	.199E 04	.322E 04	.220E 03	.314E 05	.670E 03	.298E 04
2000.0	.147E 04	11.5	.153E 05	.209E 04	.312E 04	.211E 03	.377E 05	.690E 03	.340E 04
3000.0	.170E 04	9.9	.102E 05	.243E 04	.317E 04	.229E 03	.513E 05	.695E 03	.400E 04
5000.0	.231E 04	8.2	.252E 05	.330E 04	.365E 04	.311E 03	.800E 05	.710E 03	.491E 04
8000.0	.333E 04	7.3	.368E 05	.474E 04	.468E 04	.466E 03	.124E 06	.791E 03	.622E 04



TABLE 39 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0 ECCENTRICITY RATIO = .1

$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	90.	.000E 00	.000E 00	.319E 00	.169E 00	.000E 00	.638E 00	.000E 00
.2	90.	.000E 00	.000E 00	.638E 00	.338E 00	.000E 00	.128E 01	.000E 00
.4	90.	.000E 00	.000E 00	.128E 01	.676E 00	.000E 00	.255E 01	.000E 00
.6	90.	.000E 00	.000E 00	.191E 01	.101E 01	.000E 00	.383E 01	.000E 00
.8	90.	.000E 00	.000E 00	.255E 01	.135E 01	.000E 00	.510E 01	.000E 00
1.0	90.	.000E 00	.000E 00	.319E 01	.169E 01	.000E 00	.638E 01	.000E 00
1.5	90.	.000E 00	.000E 00	.478E 01	.254E 01	.000E 00	.956E 01	.000E 00
2.0	90.	.000E 00	.000E 00	.638E 01	.338E 01	.000E 00	.128E 02	.000E 00
4.0	90.	.000E 00	.000E 00	.128E 02	.676E 01	.000E 00	.255E 02	.000E 00
6.0	90.	.000E 00	.000E 00	.191E 02	.101E 02	.000E 00	.383E 02	.000E 00
8.0	90.	.000E 00	.000E 00	.255E 02	.135E 02	.000E 00	.510E 02	.000E 00
10.0	90.	.000E 00	.000E 00	.319E 02	.169E 02	.000E 00	.638E 02	.000E 00
15.0	90.	.000E 00	.000E 00	.478E 02	.254E 02	.000E 00	.956E 02	.000E 00
20.0	89.8	.555E 00	.829E 00	.595E 02	.578E 02	.116E 03	.129E 03	.115E 01
25.0	88.8	.725E 00	.182E 01	.659E 02	.639E 02	.128E 03	.153E 03	.189E 01
30.0	87.2	.131E 01	.335E 01	.724E 02	.701E 02	.140E 03	.170E 03	.381E 01
40.0	83.7	.431E 01	.772E 01	.862E 02	.827E 02	.168E 03	.195E 03	.111E 02
50.0	80.3	.100E 02	.142E 02	.992E 02	.941E 02	.196E 03	.211E 03	.220E 02
70.0	74.8	.245E 02	.238E 02	.122E 03	.113E 03	.253E 03	.233E 03	.456E 02
100.0	68.6	.486E 02	.507E 02	.148E 03	.132E 03	.334E 03	.254E 03	.806E 02
150.0	61.7	.861E 02	.830E 02	.175E 03	.150E 03	.457E 03	.266E 03	.127E 03
200.0	56.9	.118E 03	.109E 03	.192E 03	.160E 03	.567E 03	.269E 03	.161E 03
400.0	46.3	.206E 03	.177E 03	.219E 03	.173E 03	.930E 03	.276E 03	.259E 03
700.0	38.8	.277E 03	.229E 03	.222E 03	.170E 03	.135E 04	.284E 03	.353E 03
1000.0	34.7	.320E 03	.260E 03	.220E 03	.165E 03	.169E 04	.288E 03	.421E 03
1500.0	30.3	.369E 03	.294E 03	.213E 03	.157E 03	.219E 04	.292E 03	.509E 03
2000.0	27.4	.403E 03	.321E 03	.208E 03	.152E 03	.266E 04	.292E 03	.576E 03
3000.0	23.9	.460E 03	.359E 03	.200E 03	.146E 03	.344E 04	.293E 03	.678E 03
5000.0	20.1	.498E 03	.384E 03	.179E 03	.129E 03	.464E 04	.298E 03	.835E 03
8000.0	16.7	.576E 03	.441E 03	.169E 03	.122E 03	.647E 04	.289E 03	.987E 03





TABLE 40 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0      ECCENTRICITY RATIO = .2

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYX	BXY
.1	.668E-01	90.	.000E 00	.000E 00	.334E 00	.209E 00	.000E 00	.568E 00	.000E 00
.2	.134E 00	90.	.000E 00	.000E 00	.668E 00	.417E 00	.000E 00	.134E 01	.000E 00
.4	.267E 00	90.	.000E 00	.000E 00	.134E 01	.835E 00	.000E 00	.267E 01	.000E 00
.6	.401E 00	90.	.000E 00	.000E 00	.200E 01	.125E 01	.000E 00	.401E 01	.000E 00
.8	.534E 00	90.	.000E 00	.000E 00	.267E 01	.167E 01	.000E 00	.534E 01	.000E 00
1.0	.668E 00	90.	.000E 00	.000E 00	.334E 01	.209E 01	.000E 00	.668E 01	.000E 00
1.5	.100E 01	90.	.000E 00	.000E 00	.501E 01	.313E 01	.000E 00	.100E 02	.000E 00
2.0	.134E 01	90.	.000E 00	.000E 00	.668E 01	.417E 01	.000E 00	.134E 02	.000E 00
4.0	.267E 01	90.	.000E 00	.000E 00	.134E 02	.835E 01	.000E 00	.267E 02	.000E 00
6.0	.401E 01	90.	.000E 00	.000E 00	.200E 02	.125E 02	.000E 00	.401E 02	.000E 00
8.0	.534E 01	-90.0	.416E 00	.590E 00	.288E 02	.257E 02	.514E 02	.595E 02	.867E 00
10.0	.662E 01	89.4	.149E 01	.230E 01	.319E 02	.287E 02	.570E 02	.717E 02	.316E 01
15.0	.948E 01	86.3	.374E 01	.662E 01	.395E 02	.353E 02	.710E 02	.945E 02	.858E 01
20.0	.119E 02	82.7	.669E 01	.113E 02	.480E 02	.420E 02	.875E 02	.109E 03	.151E 02
25.0	.140E 02	79.4	.106E 02	.163E 02	.567E 02	.484E 02	.124E 03	.120E 03	.224E 02
30.0	.158E 02	76.6	.152E 02	.212E 02	.653E 02	.544E 02	.105E 03	.128E 03	.299E 02
40.0	.189E 02	71.8	.258E 02	.310E 02	.812E 02	.645E 02	.162E 03	.143E 03	.450E 02
50.0	.214E 02	68.0	.376E 02	.408E 02	.949E 02	.724E 02	.199E 03	.148E 03	.580E 02
70.0	.253E 02	62.1	.612E 02	.586E 02	.116E 03	.835E 02	.269E 03	.154E 03	.804E 02
100.0	.295E 02	55.1	.933E 02	.803E 02	.139E 03	.933E 02	.364E 03	.160E 03	.108E 03
150.0	.343E 02	49.7	.137E 03	.107E 03	.160E 03	.101E 03	.505E 03	.167E 03	.144E 03
200.0	.376E 02	45.4	.172E 03	.128E 03	.173E 03	.105E 03	.629E 03	.171E 03	.173E 03
400.0	.453E 02	35.4	.261E 03	.176E 03	.189E 03	.108E 03	.104E 04	.181E 03	.253E 03
700.0	.507E 02	30.3	.329E 03	.212E 03	.189E 03	.104E 03	.150E 04	.188E 03	.332E 03
1000.0	.541E 02	26.8	.373E 03	.234E 03	.185E 03	.998E 02	.189E 04	.191E 03	.389E 03
1500.0	.598E 02	23.3	.435E 03	.267E 03	.184E 03	.982E 02	.250E 04	.192E 03	.460E 03
2000.0	.598E 02	21.3	.445E 03	.270E 03	.171E 03	.904E 02	.290E 04	.198E 03	.521E 03
3000.0	.644E 02	13.3	.497E 03	.298E 03	.162E 03	.850E 02	.381E 04	.197E 03	.611E 03
5000.0	.707E 02	15.1	.565E 03	.334E 03	.151E 03	.786E 02	.535E 04	.195E 03	.736E 03
8000.0	.794E 02	12.4	.651E 03	.380E 03	.141E 03	.738E 02	.750E 04	.185E 03	.859E 03





TABLE 41 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0 ECCENTRICITY RATIO = .3

$\frac{F}{\phi}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
1	90.	.000E 00	.000E 00	.362E 00	.288E 00	.000E 00	.723E 00	.000E 00
2	90.	.000E 00	.000E 00	.723E 00	.576E 00	.000E 00	.145E 01	.000E 00
4	90.	.000E 00	.000E 00	.145E 01	.115E 01	.000E 00	.289E 01	.000E 00
6	90.	.000E 00	.000E 00	.217E 01	.173E 01	.000E 00	.434E 01	.000E 00
8	90.	.000E 00	.000E 00	.289E 01	.231E 01	.000E 00	.579E 01	.000E 00
1.0	90.	.000E 00	.000E 00	.362E 01	.288E 01	.000E 00	.723E 01	.000E 00
1.5	90.	.000E 00	.000E 00	.543E 01	.432E 01	.000E 00	.109E 02	.000E 00
2.0	90.	.000E 00	.000E 00	.723E 01	.576E 01	.000E 00	.145E 02	.000E 00
4.0	-89.9	.694E-01	.148E 00	.186E 02	.144E 02	.287E 02	.374E 02	.157E 00
6.0	88.9	.192E 01	.347E 01	.228E 02	.182E 02	.360E 02	.518E 02	.424E 01
8.0	86.7	.380E 01	.703E 01	.267E 02	.212E 02	.425E 02	.631E 02	.859E 01
10.0	84.3	.565E 01	.104E 02	.310E 02	.241E 02	.499E 02	.724E 02	.129E 02
15.0	79.0	.110E 02	.184E 02	.428E 02	.312E 02	.717E 02	.901E 02	.233E 02
20.0	74.7	.176E 02	.258E 02	.551E 02	.378E 02	.961E 02	.102E 03	.334E 02
25.0	71.1	.254E 02	.331E 02	.671E 02	.437E 02	.122E 03	.108E 03	.424E 02
30.0	68.1	.340E 02	.400E 02	.786E 02	.490E 02	.147E 03	.113E 03	.509E 02
40.0	63.2	.524E 02	.527E 02	.991E 02	.575E 02	.198E 03	.121E 03	.664E 02
50.0	59.5	.711E 02	.641E 02	.117E 03	.643E 02	.248E 03	.127E 03	.802E 02
70.0	54.1	.107E 03	.837E 02	.144E 03	.738E 02	.340E 03	.135E 03	.104E 03
100.0	48.6	.155E 03	.107E 03	.172E 03	.827E 02	.468E 03	.143E 03	.133E 03
150.0	42.8	.218E 03	.136E 03	.198E 03	.894E 02	.653E 03	.152E 03	.172E 03
200.0	39.0	.265E 03	.156E 03	.212E 03	.919E 02	.813E 03	.157E 03	.203E 03
400.0	31.2	.387E 03	.204E 03	.231E 03	.938E 02	.134E 04	.169E 03	.290E 03
700.0	25.8	.487E 03	.243E 03	.233E 03	.911E 02	.196E 04	.176E 03	.375E 03
1000.0	22.7	.581E 03	.281E 03	.241E 03	.937E 02	.257E 04	.177E 03	.436E 03
1500.0	20.1	.604E 03	.287E 03	.219E 03	.838E 02	.316E 04	.186E 03	.522E 03
2000.0	18.0	.655E 03	.307E 03	.212E 03	.805E 02	.384E 04	.187E 03	.587E 03
3000.0	15.4	.754E 03	.347E 03	.207E 03	.787E 02	.513E 04	.185E 03	.683E 03
5000.0	12.7	.845E 03	.383E 03	.189E 03	.719E 02	.719E 04	.182E 03	.822E 03
8000.0	10.3	.106E 04	.477E 03	.192E 03	.745E 02	.106E 05	.169E 03	.945E 03



TABLE 42 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0 ECCENTRICITY RATIO = .4

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	RXX	RYY	BXY
.1	.163E 00	90.	.000E 00	.000E 00	.408E 00	.437E 00	.000E 00	.816E 00	.000E 00
.2	.326E 00	90.	.000E 00	.000E 00	.816E 00	.874E 00	.000E 00	.163E 01	.000E 00
.4	.653E 00	90.	.000E 00	.000E 00	.163E 01	.175E 01	.000E 00	.326E 01	.000E 00
.6	.979E 00	90.	.000E 00	.000E 00	.245E 01	.262E 01	.000E 00	.489E 01	.000E 00
.8	.131E 01	90.	.000E 00	.000E 00	.326E 01	.350E 01	.000E 00	.653E 01	.000E 00
1.0	.163E 01	90.	.000E 00	.000E 00	.408E 01	.437E 01	.000E 00	.816E 01	.000E 00
1.5	.245E 01	90.	.000E 00	.000E 00	.612E 01	.656E 01	.000E 00	.122E 02	.000E 00
2.0	.326E 01	90.	.000E 00	.000E 00	.816E 01	.874E 01	.000E 00	.163E 02	.000E 00
4.0	.637E 01	87.8	.248E 01	.554E 01	.196E 02	.132E 02	.261E 02	.441E 02	.582E 01
6.0	.911E 01	83.7	.571E 01	.118E 02	.255E 02	.165E 02	.351E 02	.573E 02	.132E 02
8.0	.116E 02	80.1	.909E 01	.173E 02	.323E 02	.195E 02	.459E 02	.687E 02	.202E 02
10.0	.140E 02	77.0	.129E 02	.227E 02	.394E 02	.222E 02	.578E 02	.765E 02	.267E 02
15.0	.194E 02	71.1	.240E 02	.348E 02	.580E 02	.287E 02	.910E 02	.897E 02	.406E 02
20.0	.243E 02	66.8	.370E 02	.454E 02	.764E 02	.348E 02	.127E 03	1.000E 02	.528E 02
25.0	.288E 02	63.4	.513E 02	.550E 02	.941E 02	.404E 02	.163E 03	.108E 03	.641E 02
30.0	.330E 02	60.6	.665E 02	.638E 02	.111E 03	.454E 02	.200E 03	.115E 03	.745E 02
40.0	.404E 02	56.2	.981E 02	.798E 02	.140E 03	.542E 02	.273E 03	.125E 03	.935E 02
50.0	.467E 02	52.8	.130E 03	.939E 02	.166E 03	.610E 02	.343E 03	.133E 03	.110E 03
70.0	.573E 02	47.9	.190E 03	.118E 03	.206E 03	.713E 02	.476E 03	.144E 03	.140E 03
100.0	.693E 02	43.0	.269E 03	.147E 03	.247E 03	.811E 02	.659E 03	.155E 03	.176E 03
150.0	.837E 02	38.0	.375E 03	.183E 03	.289E 03	.901E 02	.929E 03	.166E 03	.224E 03
200.0	.937E 02	34.6	.456E 03	.209E 03	.312E 03	.940E 02	.117E 04	.173E 03	.262E 03
400.0	.118E 03	27.6	.665E 03	.271E 03	.346E 03	.986E 02	.194E 04	.189E 03	.372E 03
700.0	.140E 03	22.8	.862E 03	.330E 03	.360E 03	.101E 03	.291E 04	.197E 03	.480E 03
1000.0	.150E 03	20.4	.954E 03	.356E 03	.353E 03	.979E 02	.362E 04	.206E 03	.565E 03
1500.0	.158E 03	17.8	.104E 04	.380E 03	.333E 03	.911E 02	.465E 04	.213E 03	.675E 03
2000.0	.174E 03	15.9	.118E 04	.421E 03	.334E 03	.914E 02	.578E 04	.212E 03	.754E 03
3000.0	.187E 03	13.8	.129E 04	.454E 03	.315E 03	.864E 02	.748E 04	.214E 03	.886E 03
5000.0	.217E 03	11.2	.154E 04	.533E 03	.304E 03	.842E 02	.109E 05	.207E 03	.106E 04
8000.0	.282E 03	9.2	.204E 04	.696E 03	.328E 03	.946E 02	.164E 05	.196E 03	.122E 04



TABLE 43 DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0 ECCENTRICITY RATIO = .5

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.242E 00	90.	.000E 00	.000E 00	.483E 00	.725E 00	.000E 00	.967E 00	.000E 00
.2	.483E 00	90.	.000E 00	.000E 00	.967E 00	.145E 01	.000E 00	.193E 01	.000E 00
.4	.967E 00	90.	.000E 00	.000E 00	.193E 01	.290E 01	.000E 00	.387E 01	.000E 00
.6	.145E 01	90.	.000E 00	.000E 00	.290E 01	.435E 01	.000E 00	.580E 01	.000E 00
.8	.193E 01	90.	.000E 00	.000E 00	.387E 01	.580E 01	.000E 00	.773E 01	.000E 00
1.0	.242E 01	90.	.000E 00	.000E 00	.483E 01	.725E 01	.000E 00	.967E 01	.000E 00
1.5	.362E 01	89.8	.360E 00	.130E 01	.135E 02	.696E 01	.138E 02	.278E 02	.938E 00
2.0	.476E 01	88.4	.146E 01	.444E 01	.156E 02	.841E 01	.165E 02	.338E 02	.367E 01
4.0	.886E 01	81.0	.691E 01	.156E 02	.255E 02	.121E 02	.294E 02	.531E 02	.161E 02
6.0	.126E 02	75.4	.136E 02	.257E 02	.370E 02	.144E 02	.459E 02	.637E 02	.272E 02
8.0	.161E 02	71.2	.213E 02	.343E 02	.492E 02	.163E 02	.645E 02	.728E 02	.370E 02
10.0	.195E 02	68.1	.297E 02	.421E 02	.615E 02	.183E 02	.842E 02	.810E 02	.458E 02
15.0	.277E 02	62.5	.530E 02	.590E 02	.918E 02	.235E 02	.137E 03	.984E 02	.651E 02
20.0	.355E 02	58.7	.798E 02	.737E 02	.121E 03	.290E 02	.191E 03	.112E 03	.821E 02
25.0	.428E 02	55.8	.106F 03	.870E 02	.149E 03	.345E 02	.247E 03	.124E 03	.976E 02
30.0	.497E 02	53.5	.135E 03	.993E 02	.175E 03	.398E 02	.303E 03	.133E 03	.112E 03
40.0	.622E 02	49.8	.193E 03	.121E 03	.223E 03	.494E 02	.414E 03	.148E 03	.138E 03
50.0	.735E 02	47.0	.252E 03	.141E 03	.265E 03	.581E 02	.524E 03	.160E 03	.162E 03
70.0	.925E 02	42.8	.363E 03	.175E 03	.332E 03	.713E 02	.733E 03	.176E 03	.202E 03
100.0	.115E 03	38.6	.512E 03	.217E 03	.405E 03	.847E 02	.102E 04	.192E 03	.253E 03
150.0	.142E 03	34.1	.715E 03	.268E 03	.481E 03	.980E 02	.145E 04	.209E 03	.321E 03
200.0	.163E 03	31.2	.890E 03	.308E 03	.529E 03	.106E 03	.184E 04	.220E 03	.375E 03
400.0	.212E 03	25.0	.131E 04	.406E 03	.606E 03	.117E 03	.312E 04	.244E 03	.535E 03
700.0	.264E 03	20.7	.176E 04	.510E 03	.662E 03	.129E 03	.479E 04	.257E 03	.694E 03
1000.0	.272E 03	18.6	.187E 04	.528E 03	.628E 03	.120E 03	.581E 04	.274E 03	.824E 03
1500.0	.299E 03	16.1	.212E 04	.584E 03	.613E 03	.116E 03	.767E 04	.281E 03	.983E 03
2000.0	.336E 03	14.5	.244E 04	.660E 03	.629E 03	.121E 03	.963E 04	.281E 03	.110E 04
3000.0	.354E 03	12.6	.263E 04	.698E 03	.585E 03	.112E 03	.123E 05	.288E 03	.130E 04
5000.0	.431E 03	10.2	.328E 04	.852E 03	.588E 03	.116E 03	.184E 05	.278E 03	.156E 04
8000.0	.578E 03	8.5	.446E 04	.115E 04	.666E 03	.140E 03	.279E 05	.272E 03	.183E 04





TABLE 44

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0                      ECCENTRICITY RATIO = .6

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
1	3.68E 00	90.	.000E 00	.000E 00	.613E 00	.134E 01	.000E 00	.123E 01	.000E 00
2	3.73E 00	90.	.000E 00	.000E 00	.123E 01	.268E 01	.000E 00	.245E 01	.000E 00
4	3.77E 01	90.	.000E 00	.000E 00	.245E 01	.537E 01	.000E 00	.491E 01	.000E 00
6	3.81E 01	90.	.000E 00	.000E 00	.368E 01	.805E 01	.000E 00	.736E 01	.000E 00
8	3.84E 01	89.7	.312E 00	.168E 01	.122E 02	.472E 01	.929E 01	.248E 02	.912E 00
1.0	3.86E 01	88.5	.999E 00	.433E 01	.137E 02	.550E 01	.108E 02	.288E 02	.275E 01
1.5	3.88E 01	84.4	.318E 01	.103E 02	.180E 02	.675E 01	.151E 02	.375E 02	.810E 01
2.0	3.89E 01	80.5	.587E 01	.160E 02	.228E 02	.730E 01	.205E 02	.438E 02	.138E 02
4.0	3.90E 02	69.9	.203E 02	.345E 02	.451E 02	.710E 01	.485E 02	.596E 02	.337E 02
6.0	3.91E 02	64.1	.379E 02	.438E 02	.680E 02	.659E 01	.809E 02	.727E 02	.503E 02
8.0	3.92E 02	60.3	.570E 02	.611E 02	.905E 02	.660E 01	.115E 03	.844E 02	.648E 02
10.0	3.93E 02	57.6	.771E 02	.724E 02	.113E 03	.709E 01	.150E 03	.953E 02	.781E 02
15.0	3.94E 02	53.2	.130E 03	.930E 02	.166E 03	.988E 01	.240E 03	.119E 03	.108E 03
20.0	3.95E 02	50.3	.186E 03	.121E 03	.217E 03	.141E 02	.332E 03	.140E 03	.134E 03
25.0	3.96E 02	48.1	.244E 03	.142E 03	.266E 03	.191E 02	.426E 03	.157E 03	.158E 03
30.0	3.97E 02	46.3	.303E 03	.161E 03	.312E 03	.245E 02	.521E 03	.172E 03	.181E 03
40.0	3.98E 03	43.5	.424E 03	.197E 03	.398E 03	.353E 02	.710E 03	.196E 03	.223E 03
50.0	3.99E 03	41.4	.545E 03	.229E 03	.476E 03	.458E 02	.897E 03	.216E 03	.260E 03
70.0	4.00E 03	38.1	.732E 03	.285E 03	.610E 03	.647E 02	.126E 04	.244E 03	.326E 03
100.0	4.01E 03	34.6	.111E 04	.353E 03	.758E 03	.850E 02	.178E 04	.272E 03	.408E 03
150.0	4.02E 03	30.8	.157E 04	.442E 03	.930E 03	.108E 03	.256E 04	.302E 03	.520E 03
200.0	4.03E 03	28.3	.196E 04	.514E 03	.105E 04	.125E 03	.329E 04	.321E 03	.611E 03
400.0	4.04E 03	22.8	.297E 04	.638E 03	.125E 04	.149E 03	.565E 04	.364E 03	.879E 03
700.0	4.05E 03	19.1	.411E 04	.883E 03	.142E 04	.178E 03	.879E 04	.396E 03	.116E 04
1000.0	4.06E 03	17.1	.439E 04	.917E 03	.135E 04	.163E 03	.107E 05	.422E 03	.138E 04
1500.0	4.07E 03	14.8	.515E 04	.104E 04	.136E 04	.155E 03	.144E 05	.434E 03	.165E 04
2000.0	4.08E 03	13.4	.585E 04	.116E 04	.139E 04	.173E 03	.179E 05	.442E 03	.187E 04
3000.0	4.09E 03	11.6	.645E 04	.126E 04	.132E 04	.155E 03	.233E 05	.452E 03	.221E 04
5000.0	4.10E 03	9.5	.829E 04	.158E 04	.138E 04	.184E 03	.352E 05	.443E 03	.267E 04
8000.0	4.11E 05	8.0	.115E 05	.216E 04	.163E 04	.238E 03	.538E 05	.451E 03	.320E 04





TABLE 45

DIMENSIONLESS BEARING LOADS, LOAD ANGLES, AND SPRING AND DAMPING CONSTANTS

PRESSURE RATIO = 6.0      ECCENTRICITY RATIO = .7

	$\bar{F}$	$\phi$	KXX	KYY	KXY	KYX	BXX	BYY	BXY
.1	.603E 00	90.	.000E 00	.000E 00	.862E 00	.292E 01	.000E 00	.172E 01	.000E 00
.2	.121E 01	90.	.000E 00	.000E 00	.172E 01	.583E 01	.000E 00	.345E 01	.000E 00
.4	.240E 01	89.0	.450E 00	.322E 01	.118E 02	.324E 01	.637E 01	.242E 02	.143E 01
.6	.350E 01	85.0	.206E 01	.883E 01	.157E 02	.389E 01	.911E 01	.319E 02	.548E 01
.8	.456E 01	80.9	.433E 01	.150E 02	.199E 02	.362E 01	.127E 02	.362E 02	.103E 02
1.0	.560E 01	77.2	.714E 01	.204E 02	.247E 02	.287E 01	.171E 02	.397E 02	.150E 02
1.5	.817E 01	70.0	.150E 02	.310E 02	.378E 02	.224E 00	.307E 02	.471E 02	.259E 02
2.0	.107E 02	65.1	.265E 02	.397E 02	.511E 02	-.261E 01	.461E 02	.530E 02	.356E 02
4.0	.210E 02	55.0	.755E 02	.660E 02	.102E 03	-.113E 02	.114E 03	.725E 02	.676E 02
6.0	.312E 02	50.5	.128E 03	.877E 02	.150E 03	-.168E 02	.184E 03	.900E 02	.943E 02
8.0	.413E 02	47.8	.183E 03	.108E 03	.196E 03	-.207E 02	.256E 03	.107E 03	.119E 03
10.0	.514E 02	46.0	.238E 03	.127E 03	.241E 03	-.235E 02	.328E 03	.123E 03	.141E 03
15.0	.765E 02	43.2	.379E 03	.172E 03	.350E 03	-.276E 02	.510E 03	.160E 03	.194E 03
20.0	.101E 03	41.4	.523E 03	.214E 03	.455E 03	-.287E 02	.695E 03	.194E 03	.243E 03
25.0	.125E 03	40.0	.659E 03	.253E 03	.557E 03	-.279E 02	.881E 03	.224E 03	.289E 03
30.0	.149E 03	38.9	.818E 03	.290E 03	.655E 03	-.256E 02	.107E 04	.251E 03	.332E 03
40.0	.195E 03	37.0	.112E 04	.358E 03	.842E 03	-.182E 02	.145E 04	.296E 03	.412E 03
50.0	.238E 03	35.5	.143E 04	.419E 03	.101E 04	-.861E 01	.182E 04	.333E 03	.485E 03
70.0	.317E 03	33.2	.203E 04	.529E 03	.133E 04	.130E 02	.257E 04	.392E 03	.616E 03
100.0	.420E 03	30.6	.289E 04	.666E 03	.170E 04	.438E 02	.365E 04	.451E 03	.780E 03
150.0	.558E 03	27.6	.417E 04	.852E 03	.217E 04	.851E 02	.535E 04	.516E 03	.100E 04
200.0	.673E 03	25.5	.531E 04	.101E 04	.253E 04	.119E 03	.694E 04	.561E 03	.119E 04
400.0	.958E 03	20.8	.845E 04	.139E 04	.320E 04	.177E 03	.123E 05	.655E 03	.174E 04
700.0	.127E 04	17.6	.120E 05	.182E 04	.380E 04	.248E 03	.193E 05	.738E 03	.234E 04
1000.0	.135E 04	15.7	.131E 05	.193E 04	.371E 04	.228E 03	.241E 05	.786E 03	.280E 04
1500.0	.158E 04	13.7	.159E 05	.225E 04	.387E 04	.250E 03	.329E 05	.817E 03	.337E 04
2000.0	.176E 04	12.4	.181E 05	.251E 04	.399E 04	.271E 03	.407E 05	.844E 03	.384E 04
3000.0	.194E 04	10.8	.205E 05	.277E 04	.389E 04	.268E 03	.537E 05	.868E 03	.458E 04
5000.0	.250E 04	8.9	.270E 05	.356E 04	.422E 04	.332E 03	.819E 05	.873E 03	.559E 04
8000.0	.348E 04	7.7	.332E 05	.495E 04	.514E 04	.477E 03	.126E 06	.927E 03	.689E 04



## APPENDIX D

### Table of Integrals

The following definite integrals are used in evaluating equations 28 and 29 and equations 37 through 44 for the non-cavitated case.

$$1. \int_0^{2\pi} \frac{\cos \theta \sin \theta d\theta}{(1+n \cos \theta)^3} = 0$$

$$2. \int_0^{2\pi} \frac{\sin^2 \theta d\theta}{(1+n \cos \theta)^3} = \frac{\pi}{(1-n^2)^{3/2}}$$

$$3. \int_0^{2\pi} \frac{\sin^3 \theta d\theta}{(1+n \cos \theta)} = 0$$

$$4. \int_0^{2\pi} \frac{\cos^2 \theta d\theta}{(1+n \cos \theta)^3} = 0$$

$$5. \int_0^{2\pi} \frac{\sin^2 \cos \theta d\theta}{(1+n \cos \theta)^4} = \frac{n \pi}{(1-n^2)^{5/2}}$$

$$6. \int_0^{2\pi} \frac{\sin \theta \cos^2 \theta d\theta}{(1+n \cos \theta)^4} = 0$$



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